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VOL. CLIII.—No. 3977] LONDON: FRIDAY EVENING, APRIL 1, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Royal Corps of Naval Constructors.

A COMPETITIVE EXAMINATION for a POST as PROBATIONARY ASSISTANT CONSTRUCTOR will be held at the Royal Naval College, Greenwich, during the first fortnight in July next.

Candidates must not be more than 24 years of age on 1st October next, and must then have been engaged in practical shipbuilding work for at least 18 months. Graduates from the Universities are preferred.

The salaries and other conditions of service are given in full in the regulations of the Royal Corps of Naval Constructors. The salaries during the two or three years' Greenwich course, INCLUDING cost-of-living bonus reckoned at its present rate of 50, are approximately as follow :—

Probationary Assistant Constructors on joining R.N. College, £172 in addition to mess allowance.

Probationary Assistant Constructors during second half of course, £196 in addition to mess allowance.

Candidates successful at the end of the R.N. College course will be admitted into the Royal Corps of Naval Constructors as permanent Civil Servants, with corresponding superannuation and other privileges ; the salaries, including bonus as above, of the lower grades being approximately as follows :—

2nd Class Assistant Constructor (first 3 years), £294-£329.

1st Class Assistant Constructor (after 3 years), £399, rising to £668.

The salaries, &c., for the higher grades are stated in the regulations, which may be obtained from the SECRETARY of the ADMIRALTY (C.E. Branch), Whitehall, S.W. 1, to whom intending candidates must submit their names and full particulars of their educational and technical training and practical experience not later than the 30th April.

PRIVATE STUDENTS OF NAVAL ARCHITECTURE.

A QUALIFYING EXAMINATION will be held in conjunction with the above for the admission to the Royal Naval College, Greenwich, of PRIVATE STUDENTS of NAVAL ARCHITECTURE who desire to receive instruction in the course laid down for Probationary Assistant Constructor. Applications for admission as Private Students should reach the SECRETARY of the ADMIRALTY (C.E. Branch), not later than the 30th April.

Private students are required to pay a fee of £50 per session.

Applications for the regulations should be accompanied by an addressed foolscap envelope. 8355

Cambridgeshire Education Committee.

SAWSTON VILLAGE COLLEGE.

REQUIRED for the Senior School (children of ages 11 to 15), to begin duties as soon as possible, ASSISTANT MASTER to teach Elementary Engineering and Metal Work. The workshop is fully equipped with power-driven machinery. Applicants must have had a good general education and workshop experience with mechanical and electrical apparatus. Teaching experience essential.

Salary (Standard Scale L) according to qualifications and experience. There will be opportunity for work in connection with Evening Classes, for which additional remuneration will be paid.

Forms of application may be obtained on receipt of a stamped addressed foolscap envelope from the EDUCATION SECRETARY, County Hall, Cambridge. 29th March, 1932. 8336

Borough of Worthing.

MAIN DRAINAGE.
EASTERN OUTFALL WORKS.
CONTRACT NO. 1.
TO BRITISH MANUFACTURERS OF SEWAGE PUMPING PLANT.

The Council of the Borough of Worthing is prepared to receive TENDERS for the SUPPLY and ERECTION of THREE SETS of ELECTRICALLY DRIVEN VERTICAL SCREW TYPE PUMPS, capable of pumping storm water and crude sewage. The plant is to be installed in buildings which will be constructed at the Council's Eastern Outfall Pumping Station.

The works included in the contract consist of the manufacture supply and erection of three vertical spindle electric motors with hand-operated starting gear, switchboard and cables, &c., with vertical screw type pumps with all pipes, valves and connections inside the pump house, all in accordance with drawings, general conditions, and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification, and a copy of the drawings may be obtained by the manufacturers from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Sewage Pumping Plant, Contract No. 1," must be delivered at the Town Clerk's Office, Beach House, Brighton-road, Worthing, on or before Twelve Noon on the 19th day of April, 1932.

The Council does not bind itself to accept the lowest or any Tender.

(Signed) J. KENNEDY ALLERTON,
Town Clerk.
Town Clerk's Office, Worthing. 8332

County Borough of Sunderland

DEEP WATER QUAY.—CONTRACT NO. 6.
TO CONTRACTORS.

The Corporation of Sunderland are prepared to receive TENDERS for the SUPPLY and ERECTION of THREE PORTAL QUAY CRANES, one of 5 tons and two of 3 tons working capacity, upon a site on the new Deep Water Quay on the River Wear at Sunderland, County Durham.

The contract documents may be seen upon application to the Engineer for the scheme, Mr. W. H. S. Tripp, M. Inst. C.E., c/o River Wear Commissioners, St. Thomas-street, Sunderland, or may be obtained from him on payment of a deposit of Four Pounds by crossed cheque made payable to "The Corporation of Sunderland," which will be returned on receipt of a bona fide Tender accompanied by the whole of the documents issued.

Tenders, which will only be considered if made upon the form supplied, must be completed in accordance with the detailed instructions incorporated in the documents, enclosed in a sealed cover, endorsed "Tender for Deep Water Quay, Contract No. 6," and delivered at the office of the undersigned, Town Hall, Sunderland, not later than Noon on the 25th April, 1932.

The Corporation do not bind themselves to accept the lowest or any Tender.

H. CRAVEN,
Town Clerk.
Town Hall, Sunderland.
21st March, 1932. 8342

The Engineer

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PUBLIC NOTICES.

St. Marylebone Borough Council.

REFUSE COLLECTION VEHICLES.

The Council invite DESIGNS, SPECIFICATIONS, and TENDERS for the SUPPLY of a NEW FLEET of MOTOR REFUSE COLLECTION VEHICLES. Tenders (with designs and specifications) must be enclosed in a sealed envelope, endorsed "Tender for Refuse Collection Vehicles," and delivered to "The Town Clerk, Town Hall, St. Marylebone, W. 1," not later than Noon on Monday, the 2nd day of May, 1932. Further information as to the Council's requirements, form of contract, general and other conditions, &c., can be obtained from the BOROUGH ENGINEER. The Council do not bind themselves to accept the lowest or any Tender. 8335

Oxford County and City Mental Hospital, Littlemore, near Oxford.

APPLICATIONS are INVITED for the POST of ENGINEER and CLERK of the WORKS at the above Hospital. Applicants must be able to supervise the working of a hot water installation for domestic and central heating, the general building repairs of the Hospital, and be conversant with electricity. Previous institution experience an advantage. Salary £260 per annum (subject to a temporary abatement of £7 5s. per annum), rising by £10 yearly to £300, with house, coal, and light.

Applications, stating age and giving full particulars of experience, accompanied by copies of three recent testimonials, to be sent to the MEDICAL SUPERINTENDENT not later than 11th April, 1932, endorsed "Engineer." 8339

The National Boiler and General Insurance Co., Ltd., St. Mary's Parsonage, Manchester, REQUIRE ADDITIONAL INSPECTORS in the Lift and Crane Department. Applicants should be between 25 and 35 years of age, and be prepared to reside in any part of the country ; must be practical engineers with actual experience in construction, erection, and repair of lifts and cranes ; also must have recognised theoretical qualifications and be able to make dimensioned sketches. Duties include the examination and tests of all classes of lifts, cranes, and other lifting appliances. Salary to commence £260 per annum.

Apply in own handwriting, by letter only, marked "Lift and Crane Inspector," giving age, outline of practical training and experience, particulars of theoretical training and copies of testimonials, to EDWARD G. HILLER, Chief Engineer and General Manager. 8337

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

BOX 8262.—APPLICANTS for the POST of ASSISTANT ENGINEER are THANKED and informed that the POST is now FILLED. 8344 A

WANTED, ENGINEWRIGHT, for a South Yorkshire Colliery. Experienced in both mechanical and electrical engineering.—Address, stating age, salary, and references, 8350, The Engineer Office. 8350 A

JUNIOR SALES ENGINEER REQUIRED for London area. Sound knowledge of Steam essential. Sales experience desirable. Single, between ages of 22 and 25 preferred. Remuneration, salary excluding expenses.—Address, 8343, The Engineer Office. 8343 A

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SITUATIONS WANTED.

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SITUATIONS WANTED (continued)

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The Engineer

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This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

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For continuation of Small Advertisements see page 4.

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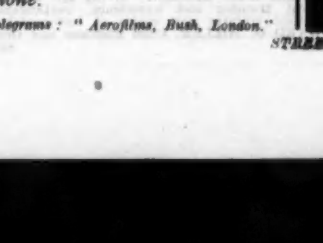

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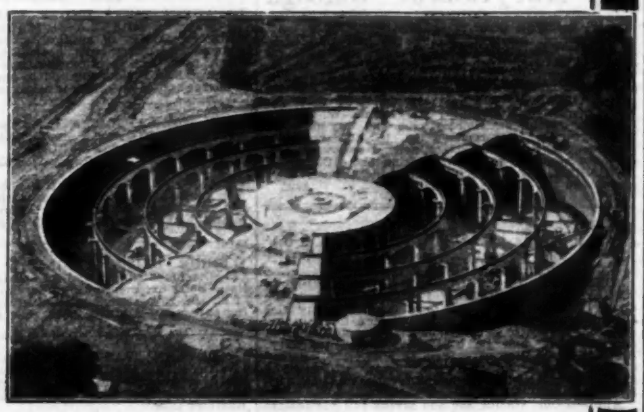

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Government of Bombay.

NOTICE.

To IRRIGATION DEPARTMENTS, PORT AUTHORITIES, RAILWAYS, MUNICIPALITIES, ELECTRIC SUPPLY COMPANIES, PUBLIC WORKS CONTRACTORS AND OTHER ADMINISTRATIONS CARRYING OUT LARGE ENGINEERING WORKS.

Notice is hereby given that, owing to the approaching completion of the Lloyd Barrage at Sukkur, large quantities of Plant and Machinery as briefly detailed in the list below will shortly become available for sale. Most of the plant is now available.

All Administrations who have works in progress or who are contemplating works in the near future are invited to consider the subjoined list and to apply to the undersigned for full particulars and prices of any plant which might be of use to them. Enquiries are now invited from machinery dealers at the present stage. Most of the plant was purchased new for these works and is in excellent condition. Every item of plant sold will be first overhauled and put in thorough working order before sale and will be open for inspection (and test, wherever possible) by appointment at Sukkur.

Service will also be given after sale and purchasers' men will be trained by arrangements, as long as the Barrage Construction Works and Shops are in existence.

A. A. MUSTO,
C.I.E., M.I.C.E., I.S.E.,
Superintending Engineer, Lloyd Barrage Circle.
Postal Address: Sukkur, Sind, India. Cables: "SUKBAR, SUKKUR."

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NOTE.—All motors on electrically driven plant are for A.C., 400 volts, 3-phase, 50 periods.

CRANES.
25-Ton and 10-Ton Electric Floating Derrick Cranes, 10-Ton and 1½-Ton Electric Derrick Cranes, 20-Ton and 2-Ton Steam Derrick Cranes. Also 5-Ton Steam Loco. Cranes and 10-Ton Electric Loco. Cranes, 5ft. 6in. gauge. Also 15-Ton, 12-Ton and 5-Ton Electric Goliath Cranes, 15-Ton Electric Shop Gantry Crane, and 15-Ton Hand-operated All-round Derrick Cranes.

PUMPS.
Sets of 8in., 4in., 3in., and 2in. Direct-coupled Electric Centrifugal Pumps for 40ft. head.

PILE DRIVERS.
Floating and Land Sets with McKiernan-Terry Double-acting Piling Hammers, Spencer-Hopwood Boilers, Zenith Winches and Steel Frames and Leads for driving 45ft. Piling.

STONE CRUSHERS.
"Acme" Jaw Crushers, 24in. by 15in., with Elevators, Hoppers and Screens and Portable Crusher, 12in. by 6in.

CONCRETE MIXERS.
Complete Plants for Moulding 10-Ton Blocks with Travelling Mixer Bridge carrying 2-Yard Ransome Mixers complete with Bunkers, Elevators and Batch Measuring Hoppers for materials, all electric driven. Also Steel Moulds for 10-Ton and 1½-Ton Blocks. Also Electric-driven Portable Mixers of sizes.

AIR COMPRESSORS.
Direct-coupled Electric-driven Sentinel Two-stage Compressors of 300 cubic feet capacity. Belt drive Ditto of 550, 300, 188, and 140 cubic feet capacity respectively. Pneumatic Tools of all kinds.

DIVING GEAR AND DRESSES, &c.

ELECTRIC POWER PLANT.
Following Diesel Engines direct coulped to Alternators generating A.C., 6600 volts, 3-phase, 50 periods:—
2 Swiss Loco. 4-Cylinder Single-acting Diesels, 750 B.H.P., with Fly-wheel Alternator, 500 kw. by Oerlikon.
Metro-Vickers Cubicle Type Switchboard.
Johnson and Phillips Transformers, 6600 to 400 volts, of sizes.
H.T. and L.T. Overhead Transmission Poles, Cables, &c.

MORTAR MILLS.
Both Over-driven and Under-driven Type Mortar Mills, 8ft. dia. pans, with belt drive from countershaft.

WORKSHOP MACHINERY.
Lathes, Shapers, Planers, Milling Machines, Drilling Machines, Belt Air Hammers, Belt Hammers, Punching and Shearing Machines, Forges, Woodworking Machinery, Plate Rolls, Iron and Brass-foundry Equipment, Saw Sharpening Machines, &c.

QUARRY PLANT.
Compressed Air Drills of all sizes, Forging Machines, Oil Furnaces, Air Compressors, Oil Engines, Wire Saws, Channellers, &c.

STONE DRESSING PLANT.
Diamond Saws, Planers, Frame Saws, Rip Saws, Countershafts, &c.

ENGINES.
Oil Engines of various sizes.

BUILDINGS.
Steel-framed Stone Dressing Shop, 360ft. by 115ft., with 15-Ton Gantry Runway and numerous Smaller Steel Roof Trusses, &c.

STEEL SHEET PILING.
About 11,000 Tons "Universal" 15in. by 5in. by 45 lb. per square foot Interlocking S.S. Piling in 40ft., 45ft., and 50ft. lengths.

MISCELLANEOUS PLANT.
Such as Steel Riveted and Sectional Tanks of all sizes, with and without Staging, Winches, Jacks, Pulleys, Wire Ropes, Motor Lorries, and many other items.

A. A. MUSTO,
S.E.I.B.C.
MS.13/10. P.B. 40/30. 8322

A Seven-Day Journal

High-Speed Seaplanes.

IN a lecture before the Royal United Service Institution last week, Wing Commander A. H. Orlebar gave some interesting details concerning the ease and the difficulties of control of Schneider Trophy seaplanes. It appears that although the racing seaplane is very much like any ordinary aeroplane to fly, conditions at the take-off and landing are peculiar. When first accelerated on the water it tends to swing uncontrollably to the left until sufficient speed is gained for the rudder to become operative. Owing to the clouds of spray the pilot can see nothing. During the later stages of the take-off the stresses on the floats are enormous; and the pilot is very conscious of uneven water. Once in the air the machines are very easy to fly, and control is quite straightforward. Last year's machines, for instance, could be flown at a speed of about 330 miles per hour with hands and feet off the controls. There is, according to Wing Commander Orlebar, little sensation of speed. In landing, the seaplane has to be flown at 160 miles per hour if it is not to sink so rapidly that the right moment to flatten out becomes difficult to judge. Once on the water deceleration is so rapid that the pilot must brace his shoulders back lest he be thrown forward and break his goggles on the windscreen. All the accidents last year occurred either at take-off or on landing. Wing Commander Orlebar confessed that the races for the Trophy had, in effect, only produced a freak aircraft, which could do nothing useful, but he was of the opinion that a vast amount of knowledge had been gained, and that the money spent had taught lessons from which concrete results could be deduced.

The T.U.C. and Shipbuilding.

THE General Council of the Trades Union Congress decided on Wednesday, March 23rd, to communicate certain proposals for Government assistance to shipbuilding and the shipping industry to the President of the Board of Trade. It is suggested that a modified form of trade facilities should be reintroduced for shipbuilding. Alternatively, the proposal is put forward that the effect of the Import Duties Act should be extended in such a way that engineering works not actually attached to registered shipbuilding yards should be able to recover import duties levied on materials used in the execution of marine engineering orders. It will be remembered that the Act referred to above exempts from duty material imported directly into a shipyard for use in shipbuilding and provides that where goods are brought into a registered shipbuilding yard from any other part of the United Kingdom they may be treated, for the purpose of drawback, as exported from the United Kingdom. In effect, the General Council suggests that these regulations should apply to engineering establishments as far as marine engineering work is concerned. Thirdly, it is proposed that the Government could assist the industry by buying up an appreciable amount of old and idle tonnage at present scrap prices and re-sell it for breaking up when the iron and steel market revives.

Coke Ovens for Blast-furnace Gas.

WE have just received the intimation that the first battery of coke ovens to be heated by blast-furnace gas in this country is now in operation at the Scunthorpe works of John Lysaght, Ltd., and is now carbonising over 1000 tons per day of washed crushed coal. The plant consists of forty-seven Becker ovens heated by cleaned cold blast furnace gas. By heating the coke ovens in this manner the whole of the gas made in them is available for use in the steel works for such purposes as heating open-hearth furnaces, soaking pits, and reheating furnaces, and by employing it J. Lysaght, Ltd., is the first firm of steel manufacturers so to balance its fuel requirements that the whole of the thermal demands of the works is met by the blast-furnace gas and the coke oven gas produced thereby. It is anticipated that considerable saving in fuel consumption will be effected. The complete by-product coking installation was designed, erected and put into operation by the Woodall-Duckham Vertical Retort and Oven Construction Co. (1920), Ltd.

The City of London Electric Lighting Company.

DEALING with the results of the past year's operations of the City of London Electric Lighting Company at the ordinary general meeting held on March 23rd, Mr. J. B. Braithwaite, the chairman, said that the company's sales showed an increase of about 3 per cent. and the connections an increase of 8¼ per cent. The connections had been extremely encouraging, for during the year they had represented a load in the neighbourhood of 10,000 kW, as against between 5000 and 6000 kW during the previous year. In addition, there had been a bulk supply of 4000 kW to Southwark. The fact that the connections had gone up by 8¼ per cent. and the revenue by only 3 per cent. looked well for the current year, because it was quite clear that owing to the depression in trade the Company had not received that increase in output which it would have expected from the additional connections which it had made. That was a point in its favour when looking forward to the present year's results. It seemed an unfortunate thing that a great public utility undertaking such as the City of London Electric Lighting Company should be bombarded on all sides to supply cheap electricity to the public, and that the same people who bombarded it in that way should have no hesitation in planting upon it very large additional rates. In a full year the additional rates which it would be asked for would be £46,000, which more than wiped out the modest additional profit of £24,000. It was impossible to make reductions to consumers if the additional economies introduced were more than wiped out by hungry local authorities and other people increasing the rates. It was interesting to note that the Company had paid to the Central Electricity Board, the Joint Electricity Authority, and the Electricity Commissioners since they had been established £16,000, which had come out of the pockets of the shareholders without any compensating benefit whatever.

The Engineers' Club.

THE nineteenth annual general meeting of the members of the Engineers' Club, Manchester, was held on Tuesday, March 22nd, at the Club premises, when Mr. J. B. L. Meek, M. Inst. C.E., City Engineer, was re-elected President; and Messrs. H. Richardson, M.I. Mech. E., and J. Owden O'Brien, M.I. Mech. E., were re-elected Honorary Secretary and Honorary Treasurer respectively. The Committee's report for 1931 states that, in spite of a heavy decrease in revenue, the loss on the year's operations was only £66, which is considerably less than for the preceding year. This satisfactory result, the report states, is due in a large measure to the Committee's policy in providing accommodation for the meetings of the leading technical societies, thereby giving what so many clubs need at the present time, an evening "load." It is gratifying to the Club's supporters that this hospitality is appreciated by the technical institutions. The membership of the Club has, naturally, fallen, but nevertheless the year ended with the names of 502 members on the books. An excellent feature of its activities is a students' trust fund, which has been provided by the generosity of some of the members to enable the sons of members who display the necessary ability to continue their training and education in the engineering, architectural, and surveying professions should their parents be unable to afford the wherewithal for these purposes. This fund comprises 1122 £1 shares in the Club building company, which yield about £80 per annum, and there is over £150 in the bank.

Sir John Hunter on Industry.

AT a meeting of Sir William Arrol and Co., Ltd., on Wednesday, March 23rd, Sir John Hunter expressed strong views on the present industrial position. He was of the opinion that since the Government had caused numerous industries to feel dependent upon it during and since the war, it ought not suddenly to cease pursuing that policy in such a way that a serious loss of employment among skilled workmen would be felt. Sir John was at a loss to understand why the Government should be ready to aid some industries and not others. It seemed to him imperative that the Government should take some action if the shipbuilding and engineering industries were to regain the prosperous position they had formerly held, although he admitted that industrial depression could hardly be cured by a system of subsidies. He believed, however, that such subsidies were unavoidable in certain cases, as, for example, when our foreign competitors were so subsidised or otherwise protected. Turning to the subject of steel making, he criticised the policy by which the price of steel was maintained. Although the price of heavy steel scrap had fallen from 72s. 6d. to 37s. 6d. at the present day, that of steel was the same now as it was in December, 1929. The lowering of steel prices, he thought, might bring about an increased demand and at the same time might eliminate inefficient producers. Fixed prices, he suggested, were usually designed to perpetuate such producers.

The Trans-Saharan Railway.

THE project for the construction of a Trans-Saharan railway dates back several years. In a Journal note two years ago we recorded that the French Committee appointed two years before that to report upon the practicability of the proposal had been dissolved without any Government action following. Efforts were then made to bring the scheme before the notice of the President. In November last year, following upon a prolonged controversy about the commercial value and even the feasibility of constructing such a railway, we published a description of the scheme as envisaged by its protagonists. The news has now arrived from Paris, according to a correspondent of *The Times*, that Monsieur Edouard de Warren, a member of the Chamber and Chairman of the Trans-Saharan Committee, has written to the Prime Minister, asking him to support the efforts now being made to secure the introduction of the Trans-Saharan Railway Bill without delay. The cost of constructing a railway from the Mediterranean to the Niger is estimated to be in the neighbourhood of £21,000,000, the cost of material and transport being about £13,750,000. Monsieur de Warren believes that the delivery of material for the work would take at least four years, during which time some 35,000 persons would be employed. The case for the railway is so strong, he considers, that sooner or later it is certain to be built, and that the greatest benefit would be conferred upon several French industries if the work were begun now.

Electrification in Russia.

WE see from a recent issue of our contemporary, the *Manchester Guardian*, that, according to a Government decree just published under the signatures of Stalin and Molotoff, three big hydro-electric stations, with a total capacity of 800,000–1,000,000 kW, utilising the rivers Volga and Kama, will be completed by 1935 in the neighbourhood of Ivanovo-Vosnesensk, Nizhni-Novgorod, and Perm, the last station being designed to supply power to the neighbouring Nizhni Tagil metallurgical factories. A. V. Winter, the Director of Construction of Dnieprstroi, the 650,000 H.P. hydro-electric station on the river Dnieper, which will be completed in the next few months, has been appointed head of the new enterprises, and with his staff will be shifted from the Dnieper to the Volga, when the Dnieprstroi station is put into operation. The building of the new Volga and Kama stations is part of the second Five-year Plan, which proposes to push ahead with electricity supply faster than with any other important branch of industry.

Newcastle-upon-Tyne Electricity Supply.

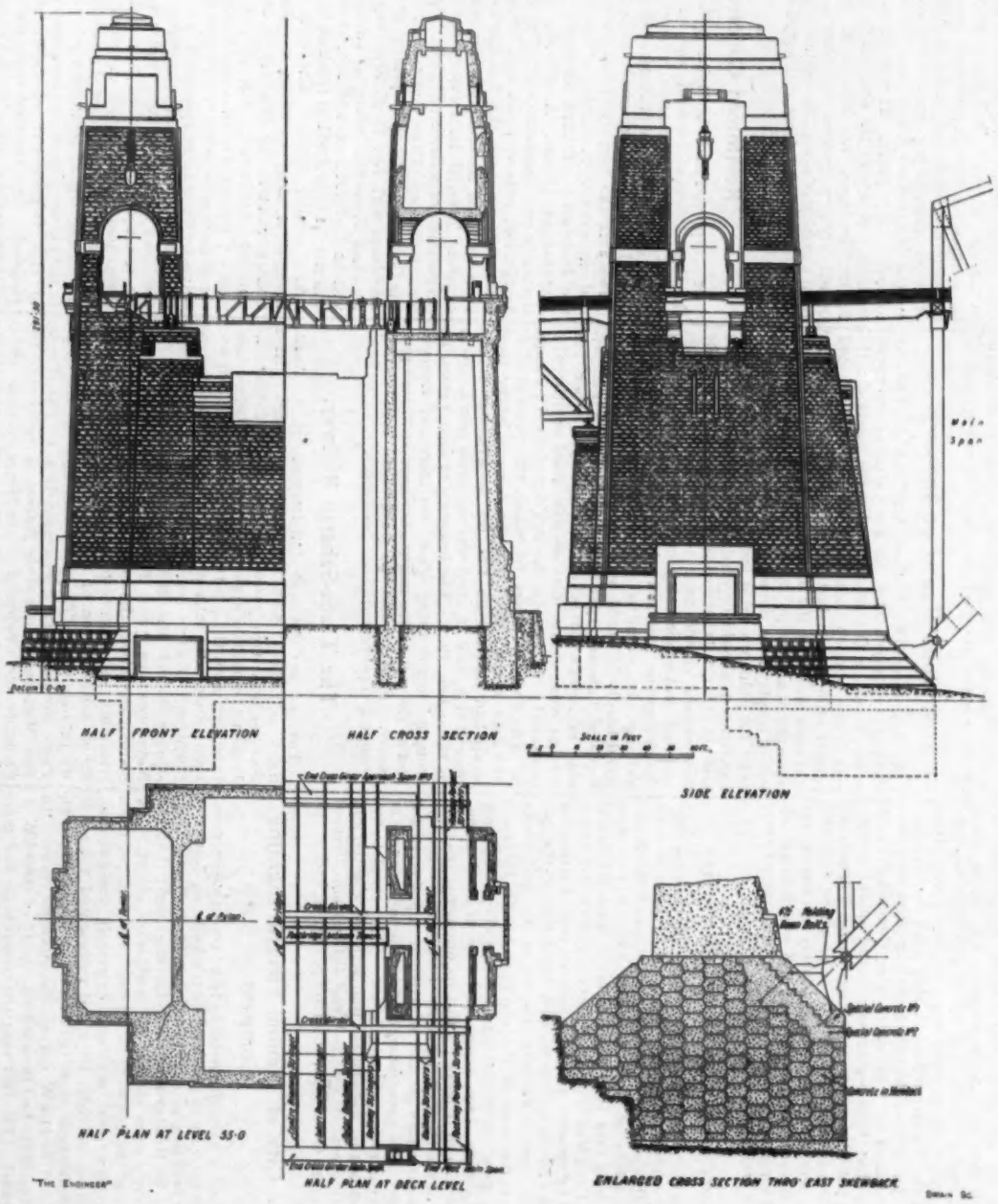
LAST Wednesday, March 30th, the Newcastle-upon-Tyne Electricity Supply Company, Ltd., held its forty-fourth annual general meeting. Mr. R. B. Sloan, chairman of the company, referring to the proposed amalgamation of companies in the area, said that in order to obtain the necessary authority for that amalgamation, a Bill had been deposited in Parliament, and there was a reasonable prospect of its becoming law without much difficulty. It was intended to alter the name of the company to the North-Eastern Electric Supply Company, Ltd. Regarding working results, he mentioned that the total new connections for the year amounted to 32,888 horse-power, the corresponding figure for 1930 having been 27,675 horse-power. During the year trading conditions had shown a further decline, which was most noticeable in the shipyards, marine engineering works, and general engineering works. In the case of shipbuilding and marine engineering, the company's sales of electrical energy during 1931 had shown a reduction on the previous year's figure of no less than 45 per cent. The production of ships on the North-East Coast was the lowest recorded for over forty years. It was interesting to record that, as a result of the company's efforts to secure further business, no less than twelve privately owned colliery generating plants, representing a total capacity of about 20,000 horse-power, had been, or would be, closed down and supplies taken from the system.

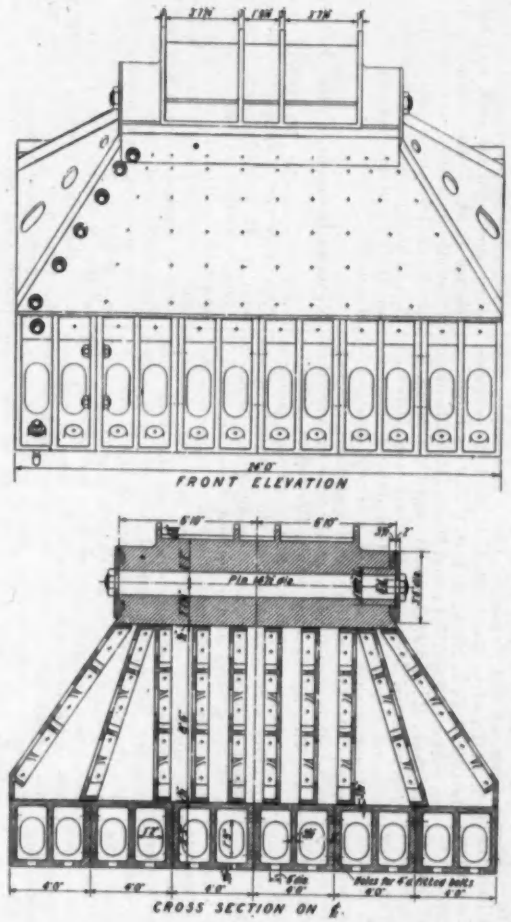
Reinforced Concrete.

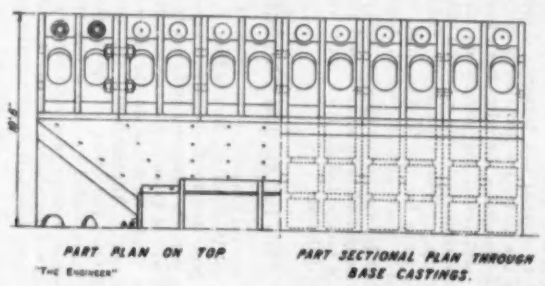
IT is reported that the Building Research Board of the Department of Scientific and Industrial Research has set up a Committee to review the methods and regulations for the use of reinforced concrete in building and to make recommendations for rules of practice embodying the best available technical information and experience. A number of institutions, including the Institution of Civil Engineers and the Royal Institute of British Architects, have agreed to nominate two members each. The British Standards Institution, however, although likewise invited, prefers rather to await the formulation of the regulations and the recommendations with the object of assisting later, if its services are required, in the preparation of a British Standard Specification based on the findings of the Committee. The functions of the Committee, which at present consists of fourteen members, with Dr. R. E. Stradling, the Director of Building Research, acting as chief executive officer, will be to formulate technical rules of practice; it will not be concerned in framing legal regulations or taking similar action. The code so formed, it is thought, is likely to prove of value to the London County Council, the Ministry of Health, and other building authorities. The proposal for setting up such a Committee as that now formed has been under consideration for some time. Recently, however, the Advisory Committee appointed by the London County Council to consider any necessary amendments to the London Building Act, 1930, was much impressed by the code of practice formulated by the Steel Structures Committee, and believed that its work would be much facilitated if a similar code was drawn up for the use of reinforced concrete. The London County Council brought this opinion before the notice of the Department of Scientific and Industrial Research, with the consequence that the institution of the new Committee was taken up.

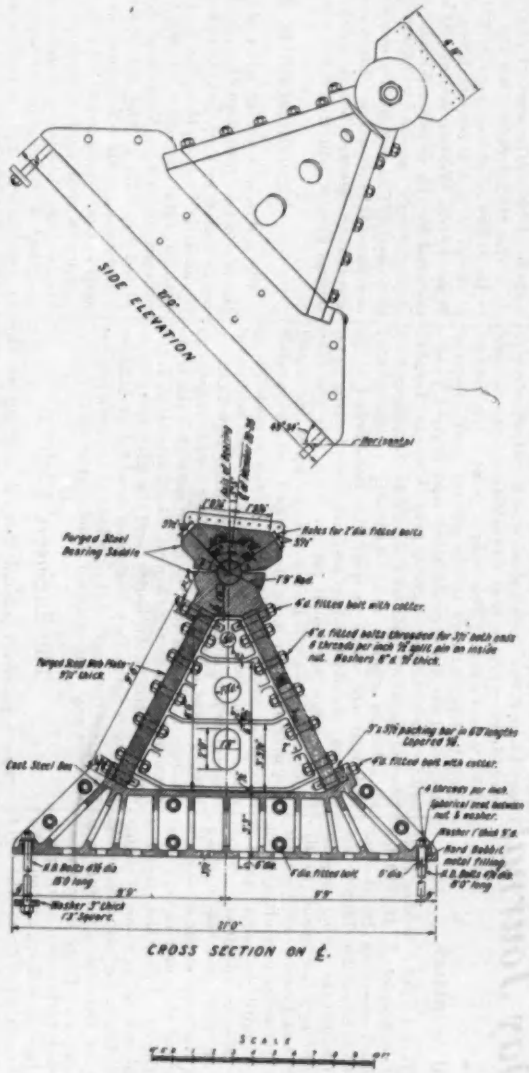
SYDNEY HARBOUR BRIDGE—PYLONS AND MAIN BEARINGS

(For description see opposite page.)









Sydney Harbour Bridge.

No. III.*

THE PYLONS AND FOUNDATIONS FOR THE MAIN BEARINGS.

THE thrust of the arch is transmitted directly to the ground through the main bearings at the ends of the lower chords of the arch trusses. The pylons, while æsthetically satisfying, do not take any of the arch thrust. Structurally, they are piers supporting the ends of the adjacent approach spans, and the ends of the arch span deck, and ornamentally they and the towers upon them form an imposing entrance to the arch span from the approaches. They have been criticised as "meaningless." For the work which they have to do, they are undoubtedly much larger than is necessary from the strictly structural point of view. Nevertheless, looking at the alternative design without pylons, illustrated in Fig. 2 of our issue for March 18th, we feel grateful to the New South Wales Government for its decision to have the piers at the sides of the harbour built to a scale commensurate with that of the arch which they flank.

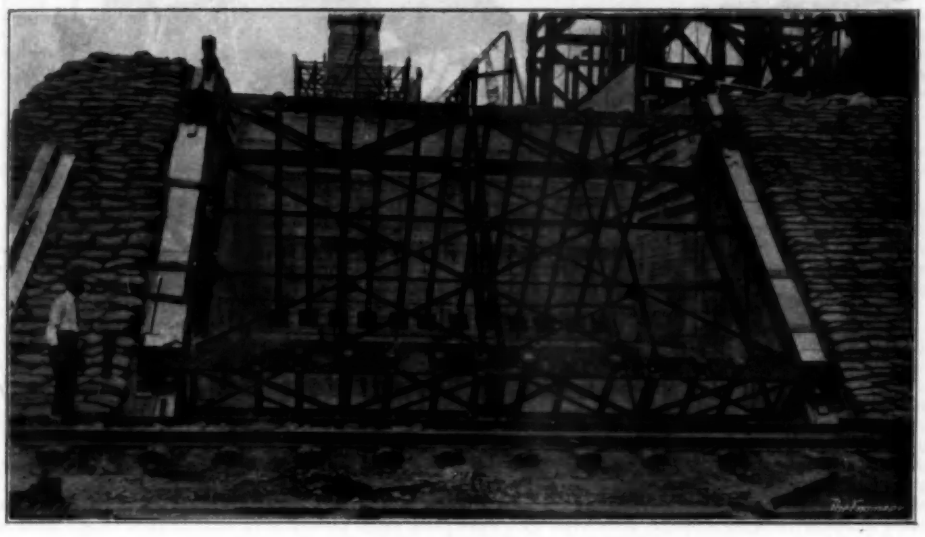


FIG. 10—TEMPLATE FOR MAIN BEARING FOUNDATION BOLTS

The pylons are concrete structures faced with granite masonry. Their architectural features were designed by Sir John Burnet and Partners. They are among the largest concrete structures ever built, and involved the solution of several special problems of design and construction. In dealing with these problems the contractors consulted Dr. Oscar Faber, M. Inst. C.E.

The pylons rise to a height of over 290ft. above Datum—mean sea level—and each covers an area at the ground level of 160ft. by 230ft. Up to the bridge deck, each pylon is in the form of a single tower. Above that level there are two towers, one on each side of the bridge. Between these two towers the roadway and the two inner railway tracks are accommodated. The outer railway tracks and the footways pass through arched openings pierced in the towers. Each tower is completed with a reinforced concrete roof. Steel staircases give access from the ground level to the tops of the towers.

The general design of one of the pylons is illustrated on page 358. The pylons are founded on rock at a level of about 10ft. above Datum. At their base the wall thickness provides an area sufficiently great to avoid the necessity for footings or deep excavations for the foundations. Up to a level of 27ft. 6in. above Datum, the pylon walls are of massive construction, and were formed against ordinary timber shuttering on the inside faces. The external granite facing up to the level named consists of very large stones, weighing 5 to 9 tons each, and was placed in position simultaneously with the deposition of the concrete. Above the 27ft. 6in. level the concrete walls were built first, the granite facing, secured by steel bonds, being added some months later. This facing is much lighter than that lower down, the stones being set in 2ft. 6in. or 2ft. courses, and having an average thickness of about 12in.

Above the 27ft. 6in. level, the pylon walls have in general a thickness of about 5ft. 6in., and are composed of 3ft. 6in. of concrete, 12in. of concrete filling, and 12in. of granite facing. For the formation of the concrete walls up to the deck level—155ft. 6in. above Datum—standardised lifting forms were employed. These forms consisted of straight sections and of special angle units for the internal and external angles. Each straight section supported a concrete face, 13ft. in length by 4ft. 6in. in depth, and consisted of a frame covered by boarding faced with flat galvanised sheeting. The forms were provided with platforms for the workmen placing the concrete. In all, 110 shuttering units were required. They were used successively for the two pylons.

The whole of the area covered by each pylon was commanded by two 7-ton steam derrick cranes, with 110ft. jibs. These cranes were erected on four timber towers, 105ft. high, founded on the rock and disposed within the area of the pylon walls. While one of these cranes was being used to place the concrete, the other was being employed to remove and refix the shuttering units within its reach. Thereafter, the duties of the two cranes were reversed. The concrete was mixed in a 1 cubic yard Ransome mixer on the ground, and was lifted and deposited between the forms by means of narrow rectangular 2 cubic yard skips provided with bottom doors which were operated by means of a hand wheel, chain and worm gear. The concrete was deposited in layers, 1ft. 6in. thick. As the forms were 4ft. 6in. deep, one position of the shuttering served for three layers. In each layer of concrete two round steel reinforcing rods were embedded, one following the periphery of the outer face and the other the periphery of the inner face of the wall.

At the deck level—155ft. 6in.—heavy reinforced concrete floors were formed over the two outer compartments of the structure for the purpose of supporting the twin upper towers. At this level construction of the pylons was temporarily stopped until the main arch had been erected. This stage, as previously noted, was reached simultaneously with the completion of the fifth approach span, and following its attainment the steel work for the roadway and railway tracks was placed on top of the pylon. While the main arch span was being erected, the granite facing and the concrete backing of the partially completed pylons was being placed in position. This work was completed by the time the main arch span was erected. For its execution portable stages were suspended from cantilevers of hardwood secured in putlog holes in the concrete towers at vertical intervals of about 27ft.

The completion of the pylons above the 155ft. 6in. level was effected by modifying the timber towers previously used on the ground and re-erecting them with their two 7-ton derrick cranes on the pylon decks. In the upper parts of the pylon towers the granite facing and the concrete walling were built simultaneously.

The granite for the facing of the pylons and also for the facing of the approach span piers was obtained from the quarry established at Moruya on the sea coast about 150 miles south of Sydney. In addition, the quarry furnished most of the aggregate for the concrete used in the pylons and piers, and for the foundations of the main bearings. An extensive equipment of cranes, conveyors, crushing, grading, and dressing machines had to be installed at the quarry site. A wharf had to be built and a complete township for the quarry workers—including even a school—had to be established. For transporting the granite and aggregate to Sydney, Messrs. Dorman, Long employed three single-screw steamers of 400 tons carrying capacity, which were built for them in New South Wales, and which they operated themselves. On their return journeys these steamers carried food supplies and all the drinking water for the quarry workers. The total output of the quarry during the execution of the contract amounted to 20,000 cubic yards of dressed granite and 120,000 tons of crushed granite aggregate.

The foundations for the four main bearings for the arch lie below the front walls of the pylons. In Dr. Bradfield's specification it was anticipated that the foundations for the bearings would not be required to be taken to a depth of more than a few feet in the rock. This expectation was not, however, realised. In order to obtain a trustworthy base free from weak seams of clay and shale, the foundations had to be taken down to a depth of 30ft. to 40ft. Each of the four excavations was 90ft. long by 40ft. wide, and was separated from the water of the harbour by a thickness of about 50ft. of rock. This intervening thickness of rock was found to be sufficiently sound and free from open fissures to prevent the ingress of water to any troublesome extent. All that was required was the formation, above the level of the rock, of puddle walls and simple cofferdams round the side of each excavation adjacent to the harbour. The site for the foundations of each bearing was examined by drilling six to eight diamond drill core bores to a depth of about 75ft. These bores showed that trustworthy sandstone extended below the actual depth of excavations required for the foundations. The minimum depth for the excavations was determined by the dimensions of the concrete required to distribute the thrust of the bearings evenly over the rock at an average pressure of about 12 tons per square foot. The actual depth of the excavations exceeded this minimum to the extent necessary to ensure that the foundations would rest on sound rock free from fissures. No difficulty was experienced in blasting the rock. The spoil was removed by means of cranes and skips and carried out to sea in hopper barges.

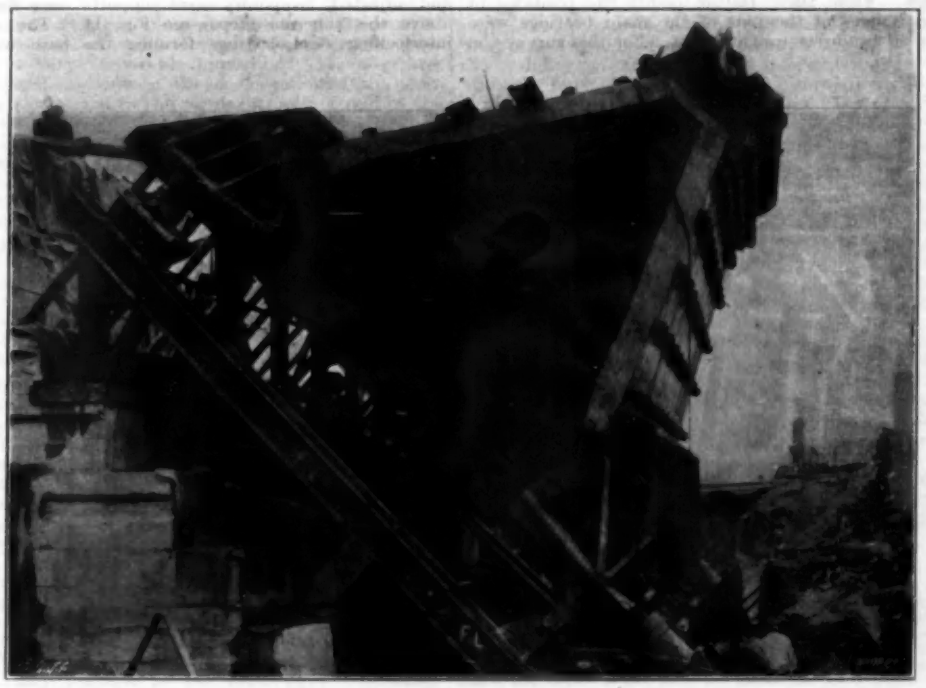


FIG. 11—MAIN BEARING BEING ADJUSTED FOR POSITION

The concrete for the foundations of the main bearings was mixed in a Ransome 1 cubic yard machine and was placed by means of bell skips. In order to achieve uniformity the concrete was placed

* No. II. appeared March 25th.

in separate sections, each of which was completed in one operation and was allowed to set before the next was placed. Two-day intervals elapsed between the pouring of adjacent sections laterally, and seven-day intervals between the pouring of vertically adjacent sections. The concrete was composed of four parts of granite crushed to a 2in. gauge, two parts of sand, and one part of cement. Immediately beneath the main bearings there were two layers of high quality, specially graded concrete of the same proportional composition. Between the bearing and the concrete the average pressure was about 40 tons per square foot, while between the concrete and the rock it was about 10 tons per square foot.

The Main Bearings.

Each of the four main bearings weighs, complete, 300 tons and carries a total load of 19,700 tons, inclined at an angle of almost exactly 45 deg. The general design is illustrated on page 358, while in Figs. 10–13, we illustrate various stages in the erection of the bearings.

The thrust from the lower chord of the arch, as will be gathered very clearly from Fig. 13, is received on an upper saddle of forged steel, which rests upon a pin 14½in. in diameter and 13ft. 8in. in length. In turn this pin sits upon a lower saddle of forged steel, which is supported by two forged steel web plates arranged in the form of an inverted V. Each of these plates is 9½in. thick, 9ft. 6in. deep, 24ft. long at the base, and 13ft. 6in. long at the top. They are connected together by ten transverse diaphragms of cast steel At their lower edges the web plates rest on six interlocking steel base castings, which are machined on their undersides and bearing faces. The base measures 21ft. by 24ft. The lower saddle, web plates, diaphragms, and base castings are all connected together by 4in. fitted bolts. The main components of the bearings were fitted to a limit of error of $^{1}/_{1000}$th of an inch, while for the bolts the limit of error was $^{1}/_{1000}$th of an inch. As already recorded, the bearings were manufactured completely by the Darlington Forge Company, Ltd.

For the purpose of determining the position of the main bearings on the north and south shores the civil engineering staff of the contractors in collaboration with the engineers of the New South Wales Public Works Department, set out two independent base lines on the north shore of the harbour. These two lines ran at an angle of about 117 deg. to the centre line of the bridge and were each about 1200ft. long. They lay close to one another, but were not exactly parallel. From these base lines triangulations were carried out to two fixed points on the centre line of the bridge, one on each side of the harbour, close to the pylons. The distance between these two fixed Datum points was established by agreement between the independent surveys from the two base lines. From these Datum points the positions of the centres of the pins of the main bearings were set off by direct measurement. For this survey the contractors employed a Cooke, Troughton and Sims 7in. micrometer theodolite with the micrometer graduated to 10 seconds of arc. The three angles of the triangulation were approximately 119 deg., 36 deg. and 25 deg., the first and second-named being adjacent to the base. These angles were the best obtainable with the only practicable base line.

The bearings were erected with the assistance of an overhead electric travelling crane, capable of lifting pieces up to 30 tons in weight. Each bearing is held down on its foundation by two rows of 4½in. bolts, with twelve bolts per row. The bolts of the upper row are 16ft. long and those of the lower 8ft., the greater length of the upper row being necessitated by the fact that during the earlier stages of the erection conditions occurred under which the upper bolts were subjected to tension. The concrete in the foundations for the main bearings was stopped short in order to permit the holding down bolts to be placed in position—see page 358. In order to locate the bolts accurately a braced steel-framed template was employed, as shown in Fig. 10. A layer of special concrete was placed over the bolts to hold them in position. This layer was finished in a step formation, which allowed a clear space of 5ft. 6in. between the steps and the base of the bearing. Subsequently, when the bearing had been placed in position and accurately adjusted, the clearance space behind its base was filled with a second layer of special concrete, which was rammed into position and provided an effective bearing over the whole of the underside of the cast steel base.

To support the bearing while it was being erected and adjusted, temporary steel supports were fixed above the concrete steps—see Fig. 11. The six interlocking steel castings forming the base were first placed in position—see Fig. 12—and then in succession the forged steel side plates—each of which weighed 30 tons—the cast steel diaphragms and the lower forged steel saddle were erected and bolted together. As assembled in this manner the bearing was resting on four hydraulic jacks, one at each corner—see Fig. 11—and in addition there were two jacks, one at each of the two lower corners, acting against the front edge in the plane of the base, and two screw jacks acting against the sides at the same corners. By these means provision was made for moving the bearing in any direction and adjusting it finely and finally at the required level and in the required alignment. The exact setting of the bearing, relatively to the Datum point previously mentioned, was accomplished by means of a theodolite set up on a rigid station on the centre line of the pin of the bearing. This theodolite was sighted on to steel discs, of the same diameter as the pin and with their centres accurately marked, which were placed in position in the lower saddle.

(*To be continued.*)

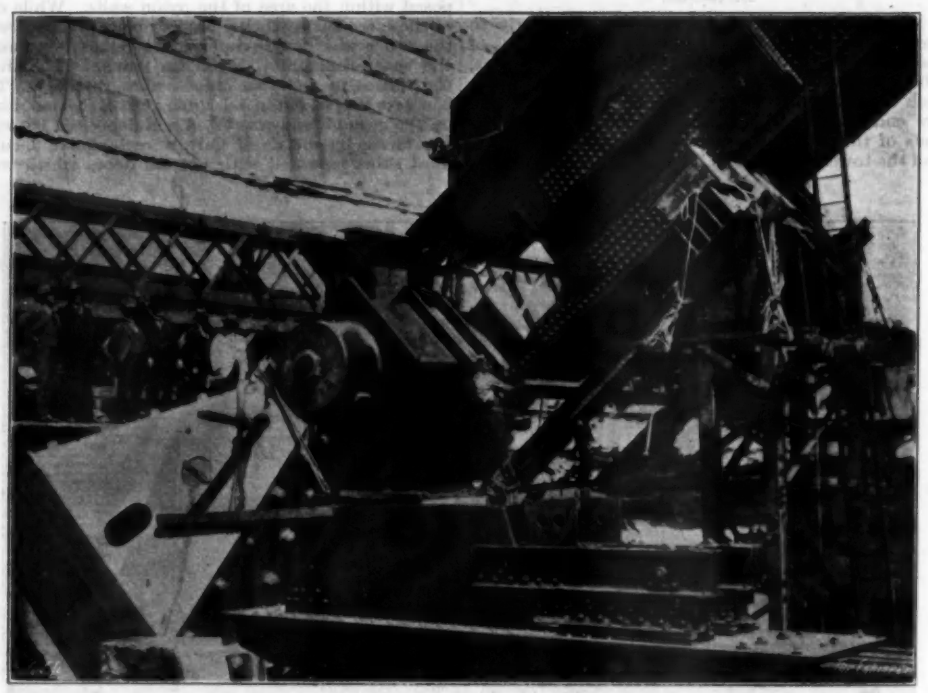


Fig. 13—First Section of Lower Chord Being Placed on Main Bearing

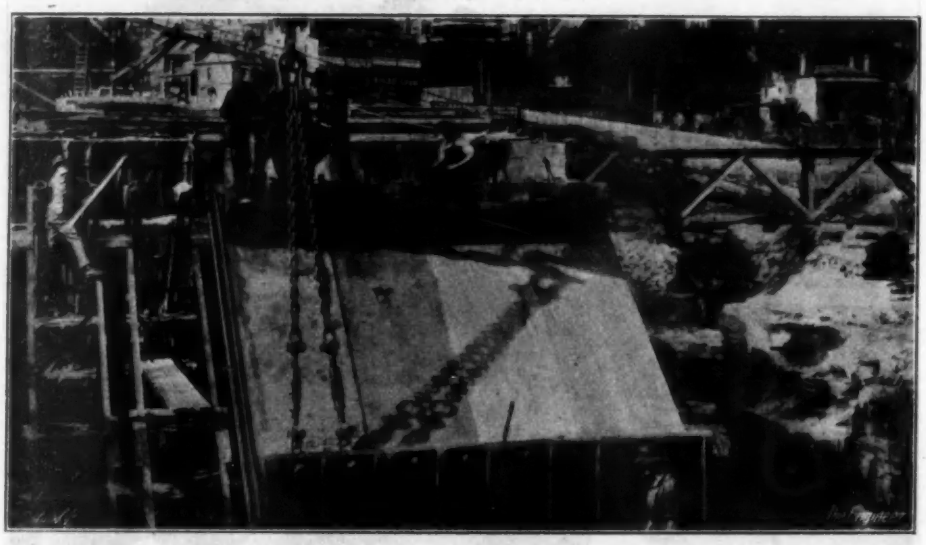


Fig. 12—Placing Base Plate Castings in Position

Institution of Naval Architects.

No. III*.

Fuel for Merchant Ships.

When the meetings were resumed on the morning of Thursday, March 17th, Mr. J. Johnson presented a paper on "Fuel for Merchant Ships," of which an abstract is concluded on page 375 of this issue.

Lord Weir, opening the discussion, said that if oil could always be sold on a thermally competitive basis with coal, no one could doubt that the use of coal as a fuel for marine propulsion would be doomed to extinction and oil would be used exclusively. Happily, such a situation did not yet exist. Oil was not sold generally on a thermally competitive basis even under to-day's abnormal market conditions. There seemed to be an essential difference between coal and oil prices. Coal prices had a kind of inherent stability which oil prices did not possess; the factors affecting coal appeared less complex and indefinite than those associated with oil, and it would appear safe to say that for some time coal would not fluctuate in price to the same extent as oil. From every angle a correct decision was of great importance, and a well-considered policy by the shipowners would count for much in the future. It was widely appreciated that our British warships must use oil to enable them to achieve their essential performances, and naturally the import of that oil supply in war time constituted a risk and a burden. If in addition our merchant navy made a decision which rendered it entirely dependent on oil, then our national war-time burden would become much heavier.

Mr. R. L. Dalgleish gave some information, as an owner of tramp vessels, trading one day in the Pacific Ocean, another day in the Atlantic, another in the Indian Ocean, and so on. The prices of coal and oil stated by Mr. Johnson, he said, might be the prices at which the liners, which had definite trades assigned to them, paid, but they were very different from the prices that tramp owners had to pay for coal and oil. Again, the quality of coal obtainable in different parts of the world differed, and very often the quantity obtained was different from that paid for. The quality of oil was different at different ports, and from time to time there was trouble owing to the qualities supplied; incidentally, when oil was carried in the double-bottom tanks, there was sediment, which meant that part of the oil had to be lost because the purifiers would not always do the work as required. He, the speaker, was concerned principally with tramps of less than 3000 H.P., which had to meet greatly varying conditions. The sea-going staffs were not permanent in the sense that the liner staffs were permanent, and a plain substantial job with a minimum of gadgets, even though the fuel consump-

* No. II. appeared March 25th.

tion might be slightly higher per I.H.P. per ton-mile than on the liner, was the better investment for the owner. He deprecated the tendency to give the engineer three or four ways of doing the same thing by duplicating and even triplicating equipment.

The extra cost of running an oil-engined ship as compared with a triple-expansion ship, on account of extra insurance on her value, was about £3 per day. The repairs to the oil engines represented twice the cost per day, and the No. 1 survey cost three times as much. Even taking all these figures into account, with depreciation at 4 per cent.—the Government allowance on income tax—the oil-engined "steamer" was a better investment than the "triple."

He believed that the price of coal would have to drop considerably below 15s. per ton if coal were to maintain its markets. He drew particular attention to the statement by Mr. Johnson that the annual consumption of British bunker coal had fallen from 30 million to 20 million tons, proving that the coal trade must reduce prices if it were to recover that trade

Mr. J. Le Mesurier discussed some of the figures in the paper and suggested that Mr. Johnson's comparison between Diesel and high-pressure steam machinery for the classes of ships designated B and C was based on incorrect consumption figures for a Diesel ship, and the estimated consumption of steamships of a size or type which had not yet been built or put to the test of actual experience. For the class C ship of 2000 H.P. the author had chosen quite an unorthodox type of machinery—the high-speed enclosed type reciprocating engine, with poppet valves—and altogether it did not seem to be a type which quite fitted the author's recommendation that propelling equipment of severe simplicity but robust enough to stand a good deal of casual treatment should be fitted. He thought that there was something wrong with Mr. Johnson's figures, where it was stated that in the B class Diesel ship the total weight was 1025 tons, and in the steamship 700 tons. The weight of the Diesel engine of the power and speed mentioned would not be more than 400 tons, so that if the total figure of 1025 tons were correct there was a balance of 625 tons to cover the auxiliaries, shafting, and seatings. How could one reconcile that 625 tons for auxiliaries, &c., in the Diesel ship with the total weight of 700 tons for the machinery of the steamship? He considered that Mr. Johnson had been very generous in regard to the space allowed for the machinery installation of the Diesel ship; there appeared to be about 15ft at the aft end and about 10ft. at the forward end of the engine.

Mr. W. J. Drummond, who was trained at the Royal Naval College after a pupilage with Messrs. Harland and Wolff, and has since been actively engaged in the coal mining industry, was able to deal with the problem with an appreciation of both points of view. He admitted at once that no useful object was served by attempting to conceal that for certain types of ships oil was the most suitable fuel. Whether in the case of such ships it would be possible in the future to supply liquid fuel derived from coal hardly came within the scope of the discussion; it was technically possible, but commercially quite impossible at the moment, and so far as he could see it could be done only as a matter of national policy by means of a subsidy or its equivalent. However, he did not appeal to shipowners to use coal in preference to oil from purely altruistic motives, but pointed to the immense progress made during the last decade on land in regard to the efficiency of power generation, using coal as a fuel. Notable ships had already been built and had demonstrated that it was quite feasible to obtain economies at sea of the same order as those obtained on land, and by substantially the same methods. He appealed for closer co-operation, therefore, between all interests involved—the marine engineers and shipbuilders, shipowners and the mining industry—for it would be welcomed by the mining industry. Perhaps the technical societies and trade organisations could do much in that direction.

Mr. G. Clephan, a mining engineer, also dealt with the problem from the point of view of the coal industry. Discussing whether the price of bunker coal could be reduced sufficiently to compete with oil, he pointed out that apparently, from Mr. Johnson's paper, on present prices there was not a great deal to choose between the two methods of ship propulsion as regards cost, and said there was no doubt that when mechanical mining was introduced into all collieries, as it had been into some, costs could be still further reduced, provided wages remained at their present level and further legislation did not hamper still more an industry already over-legislated. There was no question that the treatment of coal at the colliery so as to give a quality more nearly uniform and of a higher standard than that now supplied offered the best field for inducing the shipowner to use coal for his ships—if not altogether, at any rate for the outward voyages from home ports. Coal to-day could be so treated as to give a product, if not absolutely uniform at any rate to within 2½ per cent. of the ash in the pure coal substance; it could be done without adding moisture to the smaller sizes, and the treatment removed most of the gritty particles so injurious to pulverising plants.

Sir John Biles, after a brief reference to the history of the recent developments in steam propulsion, in which he mentioned the work of the late Sir Charles Parsons, said the remarks of Mr. Dalgleish might give the impression that the Diesel engine ship was better than the steamship, not because it gave better thermal results, but because over a number of years his ships equipped with Diesels had paid a better dividend. But he had not said how much, and Sir John imagined that it did not amount to very much, or we should have heard about it. The Diesel engined ships were operating in their most favourable waters, the Pacific, and were in competition with triple-expansion-engined ships operating elsewhere. The Diesel ship should be compared, however, with a ship having an up-to-date steam engine. The figures given by Mr. Dalgleish had shown that the amount of fuel used in the Diesel-engined ship was only a quarter, in tonnage, of that consumed by the steam-engined ship. Taking a consumption of fuel as 0·4 lb. per S.H.P. for the Diesel ship, and multiplying that by 4, one arrived at 1·6 lb., which was, for all purposes all the year round, what the triple-expansion engine would use. But a fuel consumption of 1 lb. per S.H.P.-hour was not difficult to achieve in a steam engine, taking into account all the economies that had been developed in the ships which Mr. Johnson, and others, had been responsible for. There were shipbuilders prepared to produce steamships attaining that efficiency.

The main proposition put forward by Mr. Johnson was well established—that we could produce steamships which could profitably use either coal or oil, and until the Diesel engine could be driven with powdered coal it could not possibly be in the same favourable position as the steam engine.

Mr. A. C. Hardy said that the oil industry was not the greedy, foreign, nation-destroying ogre that some of its detractors would have us believe. It would be interesting to have the views of engineers engaged in trading to the Far East in competition with Dutch vessels, on the possibility of using pulverised coal in similar ship. Such problems must be considered, not merely from the point of view of the shipowner, but also from the point of view of the shipbuilding and marine engineering interests, which, for example, were very interested in capturing a fair share of whatever foreign shipbuilding might be going, and which found it not only desirable, but advisable to develop designs of oil-using ships which could be built for owners who were always needing ships of that type. The large number of tankers built in this country for Scandinavian owners during the last three years was but one example of this.

Mr. R. J. Walker was not quite prepared to concede that the cost of a Diesel ship was no greater than that of a steamship; experience had shown the contrary, but Mr. Johnson had probably taken that view in order to place beyond dispute the advantage of being able to purchase fuel in the cheapest market. There was still a very large field of tonnage in which coal could be used to advantage. It appeared to be to the advantage of the shipowner that coal should not be driven entirely out of the marine market, but retained as an effective competitor with oil. Further, there was a very favourable opportunity for a greater co-operation between the coalowner and the shipowner in regard to the regular supply of coal of the necessary physical properties to meet the shipowners' requirements, and at a cost which was going to encourage its greater employment. No doubt Mr. Johnson would avail himself of that opportunity, as President of the Chamber of Shipping. The outstanding factor of the investigations referred to in the paper revealed that whereas the internal combustion engine was thought by some to be the most suitable type of propelling machinery for smaller and intermediate powers, it had been demonstrated that steam, with the alternative of coal or oil as fuel, would have to be seriously considered in the future as the propelling agent for all classes of tonnage.

Sir Eustace D'Eyncourt said that one of the most important aspects of the paper, if not *the* most important, was the presentation of the costs for the careful consideration of the shipowner. When Diesel engines were first fitted in merchant ships, a wonderful advance was made, and the immediate results in the economy of fuel had stood out very clearly above all other considerations. Steam engineers, however, finding themselves up against the major problem of fuel consumption, had enormously improved steam engines in that respect. That had been brought about largely by the increase in pressure and temperature of the steam; and the fuel consumption of the best steam engine, instead of being 100 per cent. greater than that of the Diesel per horse-power, was now only perhaps 20 per cent. more. Speaking generally, it appeared that Mr. Johnson, in his desire to be absolutely fair to the Diesel engine in comparison with the steam engine, had stretched points in favour of the former. One of the over-riding considerations seemed to occur when there was only a narrow margin of choice between the steam and Diesel engines. If either coal or oil could be burned in steamships, the fact that oil was a foreign product and that coal was mainly British carried much weight.

Mr. W. A. Woodeson confined his remarks to the criticisms made of pulverised coal as a fuel, and took the opportunity to dispel all doubts as to the soundness of that method of steam raising. The progress of that system of burning coal for marine purposes, he said, had been handicapped to a large extent by the unwise and grossly optimistic claims made in certain quarters during the experimental period. Disillusionment had given place to a scepticism that was proving a big drawback now that the experimental stage had been left behind. The use of pulverised coal at sea was an economic proposition and constituted sound engineering practice. More than twenty vessels were in commission with boilers fired with pulverised coal, and definite service results, which could not be ignored by the most ardent critics of the system, had been published. The change-over to oil burning, in either water-tube boiler furnaces or Scotch boiler furnaces from pulverised coal firing could be effected practically without any delay. It was admitted, of course, that coal was the most economic fuel. It was also more conducive to safety in operation, and it was obtainable from home natural sources. The advantages of using pulverised coal was not yet fully realised, owing chiefly to certain misconceptions which it would take time to eliminate. Now that the water-tube boiler and higher steam pressures were coming into more extensive use at sea, the employment of pulverised coal systems must increase. The fact that the problem of firing Scotch boilers, with very restricted areas for combustion, by this method of firing had been successfully accomplished, ensured success when firing water-tube boilers, owing to the larger available combustion chambers. The modern high-speed type of pulveriser had comparatively low power consumption, and when dealing with bituminous coal of average hardness, average ash, and moisture content, the actual amount of coal used in connection with driving the pulveriser, &c., was round about 4 per cent. of the total.

Mr. Johnson, replying to the discussion, and commenting on Lord Weir's statement that a ship equipped to burn either coal or oil had unquestionably very considerably commercial advantages, which, if they could be secured without the payment of a premium, should receive most serious consideration, said that after what had been stated in the discussion it must be concluded that those advantages could be secured without the payment of a premium. During the last decade the price of oil had on occasions reached very high levels; so had that of coal. Under the ordinary operations of commerce, there was no reason to suppose that the price of oil would not again reach high levels if there should be a scarcity, natural or contrived.

He accepted unreservedly Mr. Dalgleish's definition of tramp tonnage requirements, but could not agree that we must be governed by the standards of ten or twenty years ago. There was no reason whatever why machinery in every way suitable, embodying improved thermal and mechanical principles, should not be used by tramp owners to-day. He was rather perplexed by Mr. Mesurier's questions concerning the figures for fuel consumption, weights of machinery, and space occupied. Quite a number of shipbuilding and engineering firms in this country were ready and willing to build ships of the class discussed in the paper, under contract, at the fuel rates mentioned. That was a complete answer to any question as to the validity of the technical information given. The only fault with the technical information given in the paper was its ultra-conservatism. The weights of machinery and the figures indicating space occupied had been taken from recent periodicals illustrating installations by Burmeister and Wain, and he believed the "Amerika" was one of the vessels he had referred to. He had also examined plant produced by shipbuilding and engineering companies in this country. The published weight of the "Amerika's" machinery, which was of 6500 H.P., was 850 or 900 tons complete. If Mr. Le Mesurier could show that the figures given were unjust to Diesel installations, he would be only too happy to modify them.

The President, at the conclusion of the discussion, said that what had impressed him in connection with the comparison between coal and oil was that the price of coal was not under the command of the coal industry, but was under the command of the trade unions acting through the House of Commons. That was a question well worth considering.

The second paper to be taken on Thursday morning was entitled "Recent Improvements in the Efficiency of Small Vessels," and was written by Mr. George A. Brown. We give a *précis* of it below.

THE EFFICIENCY OF SMALL VESSELS.

This paper concerns craft between 75ft. and 250ft. in length, but many of the remarks, the author states, apply equally well to much larger craft. The question of the adoption of cruiser sterns with smaller propellers, which allow the cruiser stern to be of service under lighter draughts, is considered. It appears that a well-formed cruiser stern will reduce the power required by about 2½ per cent. Another aid to propeller efficiency is the addition of a fairing piece to the rudder post, a practice which in many cases has given, it is stated, satisfactory results, and corresponds to a power reduction of about 4 per cent. An example of this particular construction is given in the paper. In it a balanced rudder is adopted, and is combined with the design of the stern frame and propeller in such a way that the trailing edge of the propeller blades is a few inches clear of the fore edge of the rudder. Such a combination, the author states, results in a saving in propelling power of about 8 per cent. Other sources of economy discussed in the paper include the fitting of the shell plates with the butts of the plating facing forward instead of aft, a practice utilised in the German liner "Bremen." A polished bronze propeller is also deemed desirable for further power saving, which may be in the neighbourhood of 5 per cent.

In the second part of the paper a comparison is made between steam and oil engine propelling machinery for powers of 180 I.H.P. and 800 I.H.P. respectively, by which it is shown that when compared with steam engines, oil engines indicate savings of fuel and lubricating oil cost per day of the order of

30 and 16½ per cent. for the two powers, while for the larger power there is the further saving of the wages of two firemen. The question of deck auxiliary machinery is next discussed, and the author finds that electric winches are much more economical in operation than are steam winches. With a view to improving the performance of the steam engine, the increased adoption of feed heating, superheating, and air heating with forced draught is recommended, while attention is further directed to improved valve gears.

Mr. W. A. Christianson, opening the discussion, alluded to the fitting of wing fins to vessels of normal stern formation, just forward of the propeller. The fins, in addition to assisting in straightening out the stream of water meeting the propeller, had a very considerable "bilge keel effect," and substantially reduced pitching.

He pointed out that the operating cost comparison in Tables I. and II. referred to ordinary saturated steam installations, though the author had mentioned later various economy measures and modern developments.

He asked the author to give information as to capital costs, as it was likely that the Diesel vessels would cost appreciably more than the steamers. A comparison of costs, in order to be complete, must include not only operating costs, but interest and depreciation, insurance, repairs and maintenance, referred to earnings. If all these were taken into account, the final result would be rather more favourable to steam than the author had indicated.

Discussing the respective revolutions quoted by the author for the steam and Diesel engines, he said that if the lower revolutions of the steam engine corresponded to higher propeller efficiency, a greater Diesel engine power would be necessary to give a similar result. If not, then why not speed up the steam engine somewhat, save space, weight and cost, and improve its consumption? The adoption of gearing between prime mover and propeller might be justified in some cases.

Mr. J. G. Johnstone said that the savings the author had mentioned were quite in accordance with modern practice. With regard to the advantage of 8 per cent. mentioned as being obtainable as the result of fairing the streamlines around the rudder excrescences, he said he had not seen any evidence which would justify so high a figure, but it would be interesting to have more particulars. In Table II. the author had made a bald comparison between a steam engine set for 100 revolutions and a Diesel at 220 revolutions. There was a whole range of sizes and standards of revolutions open to anyone contemplating a Diesel installation, however. There was the range from 100 revolutions to, say, 250 revolutions, and he gave some figures relating to certain engines. At 100 revolutions the B.H.P. of the engine was 775, and the weight 160 tons; at 150 revolutions—a Sulzer two-stroke—the B.H.P. was 800 and the weight 135 tons; at 250 revolutions the weight was about 90 tons. The costs were roughly about £25,000 for the 100 revolutions engine, £19,000 for the 150 revolutions engine, and about £12,000 for the highest revolutions engine. It seemed to him that anyone making a comparison ought to pin down that comparison to the basis of useful work done. It was very obvious that the two engines referred to in the paper would not give the same duty; they were of the same B.H.P., but the revolutions were vastly different, and one would expect at least 7 or 8 per cent. difference in propeller efficiency, and a possibly bigger difference in rough weather.

Mr. J. H. Narbeth said that the cruiser stern had disadvantages on a small ship in short, steep waves; the seas had an uncomfortable habit of slipping over it and on to the deck when one would not expect that they were big enough to do that. He urged that, if small ships were compelled to adopt the cruiser stern, the upper deck should be as wide as possible, and that there should be a turtle deck and a good breakwater. The suggestion to fit shell plates with the butts facing forward was a complete mistake. The paint would fall out from the caulking joints and the sea would have something like sand-blasting action and would scour out the caulks so that the vessel would leak. There was nothing like sufficient evidence shown in the paper to support having the butts facing forward.

Mr. Brown, replying to the references made to the comparative costs of steam and Diesel installations, said that the extra cost in the case of the 180 I.H.P. vessel, when fitted with a Diesel engine and an electrically driven winch, driving the dynamo by means of a belt off the main engine, was about £470 over that of the steam plant. But if a high-speed Diesel engine were used, with reducing gear, under the same conditions, the cost would be about £100 less than that of a steam engine. In the case of the 800 I.H.P. Diesel machinery, with electric auxiliaries—two electric winches, electric steering gear, windlass and capstan—the extra cost would be about £2500. The 8 per cent. referred to in the paper as representing the saving in propeller power when using a balanced rudder, combined with the placing of the propeller, was a very safe figure. The lowest saving he had obtained was 9·15 per cent., and in the paper read by Mr. Woolnough and Dr. Robb in 1930—to which he had referred—the saving worked out at 11 per cent. after correcting for dry docking.

The points raised by Mr. Narbeth concerning the cruiser stern and the butts of the plating facing forward were points which British shipowners had not been inclined to take up, but a number of the foreign coasting vessels about our shores seemed to indicate that foreign owners were adopting the cruiser stern.

Screw Propellers.

Sir John Biles presided at the meeting on Thursday afternoon, when the first paper taken was one on "Screw Propellers of Varying Blade Section in Open Water," by G. S. Baker and A. W. Riddle.

The results presented in this paper form the first half of a systematic research on blade shape for single-screw ships. Twenty-seven propellers have been tested in open water, covering variation of:—(1) Radial distribution of thrust by variation of outline of blade; (2) radial distribution of thrust by radial variation of pitch; (3) blade section shape; (4) number of blades; (5) rake. The maximum variation of efficiency due to any of these changes when absorbing the same power at the same speed is:—At low power, 0·60 lowest, 0·66 highest; at high power, 0·55 lowest, 0·58 highest; if the two and six-bladed screws are disregarded.

The "normal" screw with uniform pitch, four blades and circular back sections, shows very poorly at low loading, but does quite well at high loading. The tests show that under certain conditions departures from the "normal" screw give quite good results but that the necessary combination of features in the screw depends upon the working conditions, and the blind acceptance of any so-called "aerofoil" screw will not always give a result better, and under certain conditions such a screw will be worse, than a normal circular back one.

All the tests were made with screws of unity pitch ratio, but it is believed the conclusions can be applied to any propellers for which the camber ratio and blade thickness ratio of the blade sections and blade grouping are reasonably similar to those used.

The tests were carried out on a standard open-water Froude frame. The screws were suspended at the forward end of a horizontal shaft which formed part of a parallel motion frame. The shaft was supported by vertical legs having a low resistance section, the rear leg forming a shroud for the vertical driving shaft. The horizontal shaft was also shrouded in a tube, and these shrouding tubes were filled with oil. All the tests were made at one immersion, *i.e.*, 0·75 diameter, taken at the centre of screw, and at three speeds of advance, viz., 3·3ft., 4·1ft., and 4·9ft. per second. At each steady speed, measurements of thrust, torque, and revolutions were made over a wide slip range.

Comparing the results of aerofoil screws with a normal circular back screw, there are several changes which effect a definite improvement with a screw at moderate loading. But as the loading increases, *i.e.*, as slip increases, the effect of any change diminishes, and at high slips it is quite often of opposite character to that at low slips.

All of the screws are being tested behind a 24ft. model, and some are being used in Mr. Kent's rough-water tests. These "open-water" tests have shown a number of possible paths along which to move to obtain increased efficiency, and the further tests behind models in smooth and rough water are showing which of these are the more profitable. Tests behind models in the tank have shown that efficiencies of propellers varying as much as 18 per cent. can be obtained for the same ship and engine, with the same screw centres and same stern arrangements.

Dr. G. Kempf, opening the discussion, said that he had noticed the same tendency as recorded in the paper, for a remarkable gain of speed to occur in single-screw vessels fitted with propellers having reduced pitch at the boss. It seemed to him that some misunderstanding might arise from the use of the expression "aerofoil propeller." Obviously, the author gave that name to a propeller with aerofoil sections, whereas in Germany the expression was used in relation to a propeller designed on the lines of the so-called aerofoil theory, and in which pitch and width had to be changed with the form of section, if the propeller was constructed to satisfy the same conditions as before with a maximum of efficiency. It would be an interesting completion of Mr. Baker's work if, in the second half of it, he could include the testing of a propeller designed according to that aerofoil theory.

Mr. H. G. Williams said the chief generalisations from experiments made by Admiral D. W. Taylor in 1906 were that the shape of the rear portion of the blade face had much more influence on the power absorbing and thrust-producing qualities of the propeller than the shape of the leading half of the face, but that the shape of the leading half affected the efficiency to a small extent. It was difficult, however, to disentangle the effect of one variation of blade shape from that of another, and effects due to the shape of the face of the blade might be over-powered by effects due to the shape of the back. The experiment of the authors, like Admiral Taylor's, had been restricted to a single nominal pitch ratio, and it was to be hoped that in course of time we should be presented with experiments on the effect of varying pitch ratio, at any rate in the case of the most promising sections. The experimental results in the paper all referred to ahead propulsion. The backing power of the propeller of ordinary blade sections was not very good, but it might possibly be very much worse for propellers with special blade sections. He imagined that the authorities of the Froude Laboratory would not recommend the use of any propeller having a blade section of new shape until they had satisfied themselves as to its backing power, as that was a question of great practical importance.

Mr. M. P. Payne said that experiments on lines generally similar to those described by the authors, but of a more specific nature and narrower scope, had been carried out at the Haslar Tank, and the results showed very good agreement in type of differences with those given in the paper, where the ground was common. The most extensive investigation was centred round a basic screw of 1·1 face pitch ratio and 0·726 blade area ratio, 0·07 blade thickness fraction, of zero rake, and with a relatively large boss. The blades therefore were appreciably wider than the authors'. He was most interested in conditions of relatively low slip ratio, and the results of his investigation, in common with the authors', showed that the "open" efficiency gains possible by adopting aerofoil sections were relatively small, and not fully persistent over a wide range of conditions. In particular, the results at Haslar for those conditions showed the superiority of wide-rooted blades with radially increasing pitch—in aerofoil propellers—of three blades over four, the reduction of advantage with increase in slip, and the general suitability of a type of blade section similar to that of the authors' B 29 for the particular conditions. The Haslar experiments included, in addition, tests to determine the influence of blade-thickness-fraction, a changed radial distribution of blade thickness, and variation in the size of the propeller boss. In regard to the blade-thickness-fraction, the optimum value appeared to be definitely larger in an aerofoil type of blade than in one with an ogival back. A relative thickening of the outer portions of the blade did not improve the performance. For the relatively large blades considered, however, the importance of a small boss diameter was made evident, although the advantage obtained would clearly not persist in full in narrower blades.

Mr. E. Wilding said, with regard to the comparatively small differences in efficiency which were shown in the diagrams in the paper, that care should be taken in drawing inferences where the differences were so small. His own method during the many years he had used experimental tank data was that if the difference amounted to 10 per cent., there was absolutely no doubt about it. With a 5 per cent. difference one could be almost certain; when the difference was as small as 2 per cent. it could only be regarded as probable, and when it was 1 per cent. it was doubtful.

Mr. F. McAlister said that a note of danger must be sounded as regards indiscriminate pitch reduction. The amount of reduction in pitch at the root must necessarily be adjusted so that the root sections were at the best incidence angle to the flow. The true flow in the open condition was the constant speed of advance over the screw disc with the addition of the induced in-flow. In the behind condition, the speed of flow was not constant and was variable over the disc, and it was also questionable whether the in-flow speeds at similar points were identical between the open and the behind position. Thus the best pitch reduction in the open was not necessarily the best behind a certain vessel, and it would certainly vary between different hulls. Generally, he felt surprised at the low values of efficiency in the authors' models. In the past a certain model of a hull had been passed round the various tanks for checking purposes. Would it not be possible to adopt the same procedure with a typical propeller?

Mr. Baker, replying to the discussion, said it was not suggested in any sense that finality had been reached. It was very satisfactory to hear that Mr. Rigg's experiments at the Washington Tank were confirming the results obtained at Teddington, and he congratulated Mr. Rigg on having the courage of his convictions and fitting an aerofoil screw propeller. He claimed that the authors had covered the major range for single screws, but those screws were not the right type to use for twin-screw work. They were altogether too large for the average high-speed twin screw. He did not think it right to generalise from those results to other screws and undoubtedly there were conditions in which the results in the paper began to lose their application.

(To be continued.)

In the report on atmospheric pollution for the past year, issued by the Department of Scientific and Industrial Research, Professor J. W. Cobb, of Leeds, says that he could find no support that steel was necessarily heated in a smoky atmosphere to prevent its scaling. He said, in fact, that "no fuel seems more suitable in this respect for heating steel than a producer gas made from a high temperature coke. Experienced men in the Sheffield trades are not disposed to contest this conclusion, which, if valid, destroys the 'divine right' of the heavy trades to use smoky furnaces, however convenient it may be to do so in practice. Again, steel makers have no objection to using coal gas if the price is right. Any doubt about this is dispelled by a journey up the Ruhr Valley in Germany, where coke oven gas is freely used. The comparative cleanness of the atmosphere and the towns there makes a remarkable contrast with corresponding areas in England."

Air Insulated Transformer Bank for One Million Volts.

By Dr. W. HÜTER.

WHEN the change-over was made three years ago in Germany to 220/380 kV—the highest electrical transmission pressure in Europe—the Voigt and Haeffner Company had the choice either of improving the insulation of the testing transformer set connected to the mains, which had been increased to 600 kV in 1923, or of substituting new plant. The previous 600 kV equipment had been arranged for cascade connection, and consisted of separate 100 kV oil-cooled transformers. This type of connection, usually referred to as the Dessauer connection,[1] was first applied in a practical form in 1919 by the above-named company to a 400 kV set; it effected an appreciable saving in cost over other similar plant, and offered certain technical advantages in operation.[2] Most of the high-voltage laboratories which have since been built and described have also made use of the cascade connection.[3] Closely associated with it are single-unit testing transformers, capable of giving the highest voltage at present obtainable. During 1930 descriptions of two such oil-cooled units designed to give 1 million volts (R.M.S.) to earth were published.[4]

It was recognised that no useful purpose could be served in attempting to extend the range of the 600 kV set by connecting up additional units, because the primary capacity, 60 kVA, was too small, and the stray field of the set as a whole was too great. This meant that the increased current, 0·08 ampère at 240 kV, required to trip the 100 kV oil circuit breaker used at that time, could only be obtained by strong over-excitation. The cascade set had given very satisfactory service for a period of nine years, use the cascade connection with the minimum number of transformers—two—in series. In this way the important advantages of the cascade connection were combined with the flexibility of the air-insulated transformer.

The diagram of connections is shown in Fig. 1, which also gives details of the construction of the units. The first transformer stands on the ground. The low-tension winding is placed directly on the core and is electrostatically shielded from the high-tension winding. The high-tension coils are typical of the Fischer transformer, and consist of single-layer coils of varying length and diameter wound on bakelised paper cylinders, and assembled on the vertical legs of a single-phase core. They are cross-connected in series in such a way that the highest voltage is obtained from the shortest outside coil. The two shortest cylinders of the lower transformer also carry the transfer winding, which is wound with large-section wire, for supplying the second transformer. The latter is mounted on bakelised paper supports, and is similar in construction to the first transformer, except that the transfer winding is omitted; also, at the end of the H.T. winding two large protecting rings are arranged. These can be seen in Fig. 2, and the particular form shown is still in use on the three-unit transformer bank at the Technischen Hochschule, Berlin.[6] The upper transformer showed no signs of discharge to the walls of the room up to 975 kV. When this voltage was reached discharge took place between the upper protecting ring and one of the crane rails which was 4 m. (13ft.) away; this occurred more frequently later, owing, probably, to variations in atmospheric conditions. The two transformers were otherwise entirely free from discharge up to 1 million volts, on account of the effective neutralised screening of the ends of the winding.

The capacity of the transformer bank—that is,

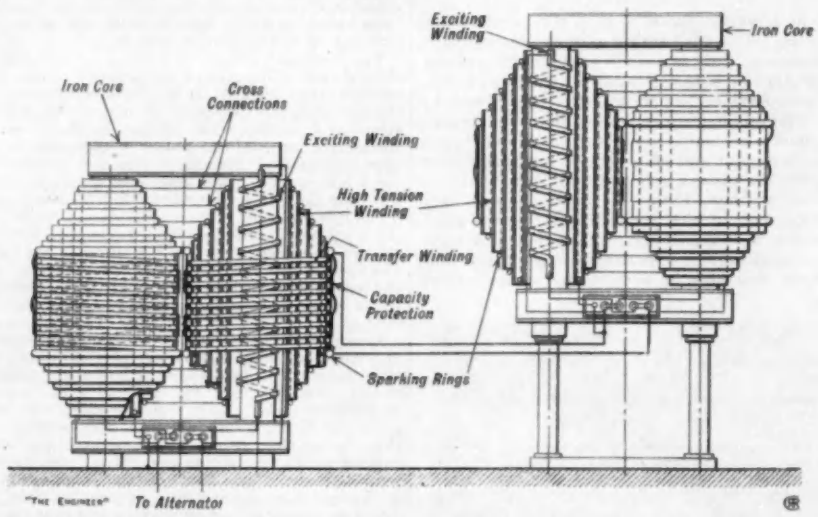


FIG. 1—DIAGRAM OF CONNECTIONS AND CONSTRUCTIONAL DETAILS OF TRANSFORMERS

even under the most severe working conditions. When breakdown occurred, which invariably took place in a single transformer, usually the top one, work could be carried on with the remainder of the set. However, repairing the oil-cooled transformers took up a considerable amount of valuable time. The handling of the multi-layer coils after frequent breakdown disturbed the inner layers, and this was not confined to the end coils alone. When the primary voltmeter broke down, it was necessary to allow the fault to develop until burning, scarcely visible at first, extended to the original point of puncture. In 1928 a year's valuable experience had been obtained with a 200 kV air-insulated transformer, built according to Professor Fischer's design,[5] in which single-layer concentric coils were arranged on the two vertical legs of a transformer core, similar to the arrangement of the metal foils in a condenser bushing. With the new equipment, however, 1 million volts to earth were to be obtained directly, and not by means of a plus and minus connection using two 500 kV transformers, which was the method employed to obtain this voltage for the first time in Germany in 1923. This latter arrangement had taken up an unnecessary amount of room, and the disposition of the object under test had been a matter of considerable difficulty, on account of the insulation spacing required to the roof or to ground. In the first Fischer transformer built for 1 million volts to earth, it was decided not to take advantage of the small stray field, but to of the feeding transformer—is 300 kVA, and this proved adequate in previous experimental work when testing objects having appreciable capacity and connected to the transformer by long leads. The leakage reactance of each transformer is 11 per cent., and of the whole set 40 per cent., since the upper transformer forms a non-resistive load to the first transformer. The advantages of using this two-stage connection of air-insulated transformers, particularly for the type of work required in a factory manufacturing high voltage plant, were anticipated, and were confirmed in almost two years' work referred to below.

The topmost point of the transformer is not at the highest potential, but has a maximum value of 500 kV (R.M.S.), and this is of importance where the set has to be housed in a building. The weight of the transformers is small in comparison with oil-cooled units of equal voltage and capacity,[7] the respective weights of the units being 6 tons and 5 tons. They can thus be moved quite easily without special lifting gear. The terminal bushings, which for very high voltage work are a great source of trouble, have not to be considered here; 220 kV bushings for potential transformers have been found to be excessively large,[8] and this difficulty would become still greater in a single-unit oil-cooled testing transformer to give 1 million volts to earth. The use of air-insulated transformers enables the insulator bushings to be dispensed with, and has the further advantage that the whole of the set is constantly under observation, so that any possible breakdown could be easily observed in the open windings, and further damage prevented. Since the ideal distribution of the field in the transformers prevented any form of discharge taking place, even at the highest voltage, experimental work could be carried out in the same room where the transformers were housed, without disturbance; humming in the core was certainly noticeable, but it was not particularly objectionable. Occasional flash-over took place in the transformers, as a result of prolonged discharge across the sphere gap, or owing to deposits of dust, but was afterwards prevented by the use of circular sparking rings connected to the ends of the coils. During two years of almost constant use, the very rare cases of breakdown were due to the formation of arcs in the high-tension winding. The fault could always be reached from the outside, and since single-layer coils were used, dismantling was not necessary. In the worst cases the upper transformer had to be lowered before the repair could be effected.

In addition to the above advantages in operation, certain useful alternative connections are possible with the two-stage cascade set:

(1) When the main leads between the two transformers are disconnected—these are provided with hand grips—and the frame of the upper transformer is earthed, it can be excited separately; by this means a 500 kV unit with improved regulation is available.

(2) At the same time the lower transformer can be connected in parallel with the upper one, and a 500 kV unit obtained with a higher kVA output and smaller leakage reactance.

(3) If the leads to one of the transformers connected as in (2) are reversed, there are two 500 kV units connected in opposition, with a maximum potential of plus and minus 1 million volts between terminals.

(4) The potential of any point may be controlled by taking tappings from the main leads connecting the transformers, or from the leads connecting the separate coils of each transformer. This is also possible, to a limited extent, with oil-cooled transformers connected in cascade, but it becomes impossible with a single oil-cooled unit.

(5) With air-insulated transformers of the above type, the cross connections of the coils may be re-arranged so that each unit has one, two or more coils in series. This gives a smaller maximum voltage, but full kVA output. Considerable use was made of this type of connection in a 200 kV Fischer transformer for testing insulating materials of various thicknesses by the Schering bridge method; for this purpose a voltage supply easily variable over a wide range was required.

The total height of the transformer bank is 7·8 m. (25·6ft.) and corresponds, therefore, to the height

FIG. 2—ONE MILLION-VOLT LABORATORY

of the oil-cooled testing transformer fitted with vertical bushings described in 1930.[9] The floor space required is 7·5 by 3·2 square metres (24ft. by 10·5ft.), and does not differ appreciably from that of oil-cooled transformers for a similar terminal voltage with horizontal bushings.[10] The transformer bank—see Fig. 2—stands in a darkened room 36·4 m. long by 13 m. wide (12ft. by 42·6ft.); the gabled roof is 12·5 m. (41ft.) high to the top point, and the side wall is 10 m. (32·8ft.) high; an electric crane with a lift of 8·3 m. (27·2ft.) runs just below the roof. Three steel folding doors, 9 m. (29·5ft.) high

[1] F. Dessauer, DRP. 336,779 of 30.9.1915 and DRP. 340,713 of 8.10.1915. The principle of the cascade connection had already been described by Vedovelli in Supplement 2 (No. 8461) of the French Patent 359,186 of 6.11.1907, and by Hendricks in *Transact.*, Am. Inst. El. Engs., Vol. 30 (1), page 176 (1911). See also Koch and Sterzel, DRP. 430,082 of 11.6.1919; K. Fischer, "Hochspannungstechnik," pages 63-64, Fig. 40, published by W. de Gruyter, 1921.

[2] "El. und Maschinenb.," Vol. 40, page 258 (1922); "ETZ," page 969 (1922).

[3] See "High Voltages Laboratories," by Fleming, in "World Power," Vol. 6, page 16 (1926).

[4] R. Crämer, "A.E.G.-Mitt.," 1930, page 491; "ETZ," 1930, page 1751; K. Draeger, "ETZ," 1930, page 934.

[5] "ETZ," 1925, page 186, DRP. 443,199.

[6] "ETZ," 1929, page 374.

[7] According to the "A.E.G.-Mitt.," 1930, page 491, for 500 kV oil-cooled transformer, weight 9 tons, total height 4·66 m. (15·3ft.). With V. and H. set, height 5·15 m. (16·9ft.).

[8] Compare A. Meyerhaus, "ETZ," 1930, page 17, lines 50 to 66, or Goldstein in W. Petersen "Forschung und Technik" (A.E.G.) Berlin, 1930, page 313.

[9] "A.E.G.-Mitt.," 1930, page 493; height 8·245 m. (27ft.) weight 31 tons (1000 kVA); "ETZ," 1930, page 1752.

[10] "A.E.G.-Mitt," 1930, page 492.

on the right-hand side lead to the testing and erecting shops for heavy plant, and two sliding doors—seen in Fig. 2—give access to a small high-voltage laboratory at the back. In the opposite wall a further steel folding door enables high-tension leads to be taken into the yard, where outdoor experimental work is carried out. The voltage of the complete bank, or, of the upper transformer when this is used separately, is measured in the usual manner by means of a sphere gap with 1 m. diameter spheres. It can be controlled from the switch desk, the lower sphere being earthed and adjustable, while the upper one is insulated and fixed. Below the sphere gap is a dial indicator for measuring the length of the gap.

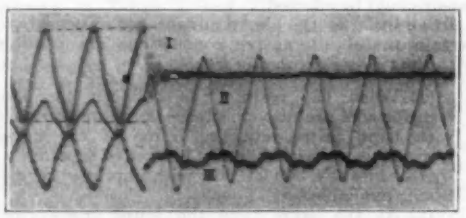


Fig. 3—Discharge Across Sphere Gap (1 Metre Dia. Spheres)

The dial is visible both from the switch desk, which is on a raised platform inside the room, and from an observation window in the erecting shop from which readings are taken.

The majority of E.H.T. switchgear is required for outdoor service, so that apparatus for reproducing rain and mist conditions is necessary for testing purposes. Oscillating nozzles, which can be arranged at ten different heights from the ground, have been installed, and rain or mist can be suitably sprayed on a 220 kV oil switch, 8 m. (26·3ft.) high. Artificial rain water is obtained by mixing distilled water and tap water, using compressed air, and is controlled by a special switchboard placed near the main operating desk. The conductivity of the mixed water can be continuously controlled by means of a suitable measuring instrument. In spite of the large number of rain tests which have been carried out during the course of two years, no signs of damage are apparent in the bakelised paper cylinders used in the transformers. Even when mist tests were carried out for several hours at a time, and salt water was used, no damage appeared to be done. When rain and mist tests of long duration were completed, the doors of the laboratory were always opened and the air thus cleared.

The large room—5200 cubic metres (184,000 cubic feet) capacity—is ventilated by means of two air-circulating fans; the floor is of concrete, and although it is not painted, the dust deposit on the transformers has not been sufficient to produce any flash-over after fourteen months' constant service. The vertical windings, in particular, have not attracted any appreciable quantity of dust, even though they have been live for considerable periods. Dust has only been deposited on the horizontal rim of the bakelised paper cylinders. All the cleaning that proved necessary was carried out by three workmen in eight working days; both transformers were completely dismantled, the cylinders and windings were thoroughly cleaned with dry dusters, and the windings reassembled ready for use again.

The end turns of the high-tension winding of the transformers were at first protected against streamer discharge by means of a capacity device consisting of three copper bands wound round each of the shortest cylinders. This proved a very effective means of protecting the high-tension windings from breakdown. Later, on the recommendation of the transformer manufacturer, a wire resistance of 100,000 ohms, wound on a bakelised paper cylinder, was connected between the sphere gap and the upper transformer. By this means overheating was prevented when a continuous load was taken from the transformers, and it undoubtedly increased the safety of the plant from an operating point of view. When discharge took place across the sphere gap and through the high-tension windings of the transformers, high voltages were induced in the low-tension windings, but these were protected by a suitable combination of resistance and capacity. The single breakdown of this type which occurred, could not be reached from the outside, so the upper transformer had to be partly dismantled. When the top yoke had been removed, only the inside high-tension cylinder had to be lifted off to reach the fault. The repair was effected with the use of a hand crane in one day.

The transformers can be excited either from a 300 kVA or a 100 kVA alternator, and, as a rule, the smaller machine was used. This capacity was sufficient for carrying out feeble puncture tests in porcelain and sillimanite supports, bakelised paper sheet, and in oil at 700 to 800 kV. It was of considerable interest to examine the high-tension voltage wave under these conditions by means of an oscillograph, the maximum voltage being calibrated by means of a spark gap. A large water resistance was connected between the high-tension side of the transformer and the oscillograph element to serve as a potential divider; this was similar to the arrangement recently used by Carroll and Cozzens.[11] The oscillogram of a discharge across the 1 m. sphere gap is shown in Fig. 3. Curve I. represents the high-tension voltage, which has a perfectly smooth path, almost sine wave in shape. The machine was connected to the transformer by means of a remote controlled switch, and it can be seen how the voltage on the high-tension side gradually increased as the exciting current became greater. When the breakdown voltage of the gap was reached, spark-over took place at the maximum point of the voltage wave, and, after a few oscillations, the voltage value across the arc was maintained. Curve II. represents the primary current, which increased at the instant of spark-over. The irregular Curve III. represents the low-tension voltage, which broke down at the moment of discharge. In the oscillograms reproduced below, the numbers I., II. and III. represent respectively the high-tension voltage, low-tension current and low-tension voltage. In Fig. 4 the oscillogram of the

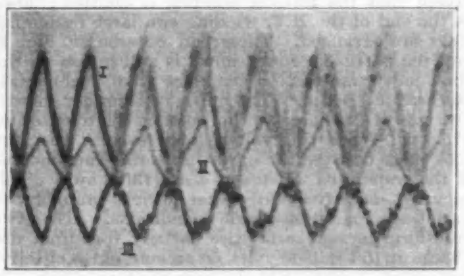


Fig. 4—Discharge Across Needle Gap

discharge of a needle gap is shown, the points being 50 cm. apart. The low-tension voltage decreased in value, in this case, only to a small extent. The voltage on the high-tension side increased to twice its original value, but experience has shown that this causes no damage. The oscillogram shown in Fig. 5 is interesting, and illustrates the incomplete breakdown occurring between a point and plate, between which a sheet of pressphahn is placed. It will be seen that the high-tension voltage, Curve I., breaks down only on one side, *i.e.*, in the positive half wave, which always occurs in a non-homogeneous field. A high-frequency component is superimposed on the normal wave, which can also be seen with the naked eye

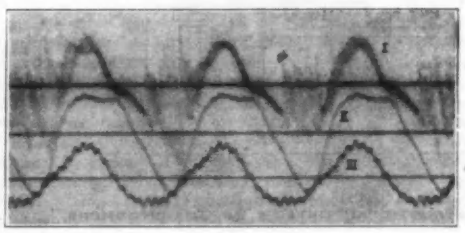


Fig. 5—Discharge Between Point and Plate with Pressphahn Barrier Between

with such discharges, in the form of corona on the thin connecting wires.

Finally, it may be mentioned that the capacity of the transformer bank, and of the exciting machine, may be adjusted according to the purpose for which the set is used. This will be different for a cable works, and an insulator and bushing works, where chain insulators are principally tested. In the case of a switchgear and transformer works, where the required capacity will lie between the above two extremes, 300 kVA will suffice, although for most requirements this is too small.

It must be emphasised that the object of testing transformer equipment is not to reproduce breakdown conditions met with in practice, although this view is contrary to most other expressed opinions. High-tension testing plant should verify, or otherwise, the dielectric properties of the insulating materials used, the type and form of the insulators, and their dielectric behaviour after assembly, both under normal conditions and with voltages higher than normal. By this means some measure of the dielectric factor of safety of the whole equipment is obtained.

Hot Cathode Thyratrons.

A paper recently read before the Rugby Engineering Society by Mr. L. J. Davies, of the B.T.H. Engineering Laboratory, deals with hot cathode thyratrons. The thyratron, it is explained, is essentially a gas-filled thermionic rectifier with a control electrode, and has the characteristics of an arc with a constant voltage drop, but controllable starting voltage. The conduction of a current by means of charged particles moving freely across a space between two electrodes is partially or completely unidirectional, and therefore offers the possibility of the rectification of A.C. The following types of rectifiers have been tried for commercial rectification:—(i.) Cold electrode gas-filled rectifiers, in which the current consists of the mixture of positive and negative charges of a gas discharge; (ii.) hot cathode high-vacuum rectifiers, in which the current consists of negative charges or electrons only; (iii.) mercury arc rectifiers, in which electrons are dragged out of a pool of mercury and then form positive ions in the mercury vapour; and (iv.) hot cathode gas-filled rectifiers, in which electrons are given off from the cathode and then form positive ions in a gas or vapour.

The last method has always been attractive, but until recently it has been unreliable. Commercial rectifiers using space currents have therefore been confined to the hot cathode, high-vacuum type, and the mercury arc type, the cold electrode gas-filled type having serious limitations as regards output. Recent work has made the combination of hot cathode and gas filling a practical proposition. The earliest hot cathode rectifiers were gassy simply because of poor pumping equipment, and they showed so many faults that every effort was made to improve pumping methods and to produce the highest possible vacuum rectifiers. In order to secure maximum efficiency, the vacuum tube designer endeavours to secure the maximum anode current for a minimum cathode temperature and anode to cathode voltage. Some internal voltage drop is, however, inevitable, for in order that a current may flow from cathode to anode, there must be a concentration of electrons. It is the stream of electrons moving across the space that constitutes the anode current, and the denser the stream the higher is this current. Wherever there is a concentration of charges of one sign there must be a potential gradient which is termed the electron space charge. The electrons already in the space prevent the entry of others. Unfortunately, in spite of knowledge of the theoretical methods of keeping the anode-cathode voltage low, practical considerations make it rather high, and actual values range from 100 to 5000 volts, according to current and inverse voltage ratings. A rectifier capable of delivering 4 ampères at 10 kV would have an internal drop of some 1000 volts. Any attempt to increase the anode current by increasing the cathode area necessitates modification of design that would give for a current of, say, 10 ampères, a drop of several thousand volts, and vacuum devices that have to dissipate such large losses internally are impracticable as regards construction as well as being inefficient.

The internal voltage drop can be lowered by any method that will neutralise the negative charge due to the electron cloud, but this can only be done by mixing positive charges with the electrons. Wires, for example, maintained at a positive potential may be placed between the anode and cathode, but power is necessary to maintain their potential. Fortunately, there is a method by which the electrons can make their own positive charges. If a moving electron is allowed to collide with a gas molecule, it can give up some of its kinetic energy to the molecule, and a positive ion results. This will happen only when the electron possesses above a certain quantity of energy. The voltage necessary to give it this energy is quite low, and varies with each gas. It is in the neighbourhood of 10–20 volts—an electron moving with a velocity due to a field of 1 volt has $1{\cdot}6\times10^{-12}$ ergs of kinetic energy.

Recently a type of cathode has been developed capable of giving very high emission currents at correct operating temperatures. When these cathodes are applied with proper recognition of the principles of space charge elimination and cathode disintegration, the thermionic gas-filled rectifiers are at once commercially possible. Previous to this, although various attempts were made experimentally to utilise gas filling, manufacture concentrated upon rectifiers of the high-vacuum type, giving low currents and only efficient on high voltages, and the mercury arc giving heavy currents at low voltages. The middle grade of high currents at high voltage has previously been missing. It is this field that the hot cathode vapour rectifier and thyratron fills, and that is why the hot cathode thyratron deserves so much attention. Not so only because it operates on the grid control principle, but also because of its particular range of output volt/ampères. Another advantage of the hot cathode thyratron is that it can and is being made in quite small, relatively cheap, and easily transportable sizes.

The presence of gas, at a low pressure, in the inert state—*i.e.*, non-ionised—can make no difference to the characteristics of the triode before current flows, and therefore does not affect the point at which it commences to flow. But as soon as anode current does flow, ionisation occurs, and the anode current ceases to be controlled by the voltage of the grid. It rises to a value decided only by external series resistance, the voltage between anode and cathode dropping to a low and constant value as in a gas-filled rectifier. If, for a given anode voltage, a value of grid voltage is found just sufficiently negative to prevent anode current, a small change to a less negative value will allow anode current to start, and consequently an arc current to flow, without further change of grid voltage. Practically no power is involved in this alteration of grid potential, for at this stage only a small current flows into or out of the grid circuit. In a thyratron therefore power can be switched on by a change in grid potential. It is not possible, however, to switch off the arc current by any change in grid potential when D.C. is used on the anode. The reason for this is that the grid becomes completely surrounded with a sheath of positive ions, and the potential presented by the grid to the space is zero. Any change of grid potential then only alters the positive ion sheath thickness, the space charge due to positive ions absorbing the potential drop between the grid and the space. Consequently, since changes of grid potential do not appear in the arc, they do not control the arc current.

Although the grid has no control over the arc current, it will regain control if by any method the grid can be cleared of its sheath of positive ions and be allowed to exert its own potential. This can only be done by reducing the anode current to zero, by removing anode volts, which only need be removed for a sufficient space of time to de-ionise the grid. This time is of the order of micro-seconds, and consequently the thyratron has its main scope in A.C. circuits, for in these circuits the anode voltage falls to zero twice per cycle. If an alternating voltage is applied to the anode, a grid voltage of similar wave form, but 180 deg. out-of-phase, that is termed the critical voltage, can be found from a knowledge of the control ratio curve.

[11] *J.*, Am. Inst. of El. Engs., Vol. 47, page 892 (1928).

At voltages more negative than this no current flows in the anode circuit, whilst at voltages less negative current passes. A circuit can thus be devised in which the thyratron can be switched on or off by a change of grid potential A control of the magnitude of the anode current from zero to a maximum value can be obtained by applying to the grid a voltage 180 deg. out-of-phase and of greater value than the critical value, and advancing the phase of the grid voltage. In this way the point along the time base at which the applied grid voltage equals in value the critical value is then varied, and therefore the mean value of the anode current. The phase shift method is a very valuable method of utilising thyratrons.

The constants of the cathode that interest the user are heating watts and the current delivering capacity. The ratio of these give the cathode efficiency. The user is also interested in cathode life. In normal cathodes, as used in high-vacuum high-voltage tubes, these three constants are closely and definitely related, for in such tubes cathodes of the open filamentary type only are permissible. While with these cathodes an increase of temperature gives a much higher efficiency, it gives a much shorter life, owing to increased rate of evaporation of the filament. In order to secure a reasonable efficiency, the temperature of a tungsten cathode is usually such as to limit its life to a value between 1000 and 6000 hours. The efficiency of a cathode, *i.e.*, ampères of emission per watt of heating energy, depends upon the material from which it is made, and it has been found that cathodes of the coated type, in which a film of thorium or barium is carried upon a core of tungsten or nickel, are many times as efficient as plain tungsten, and this is particularly the case with barium-coated nickel. Unfortunately, coated filaments cannot be used in high-voltage high-vacuum valves, owing to positive ion disintegration, for even in a so-called high-vacuum there is a certain amount of positive ionisation. Owing to the low anode to cathode drop in a space charge free thyratron, oxide-coated cathodes can be used. They are fitted in the form of ribbon filaments coiled or bent in zigzag form. A form which is now being used wherever possible is the indirectly heated, heat-shielded type. This indirectly heated type merits special attention, for it is the most efficient form of cathode known, but its use is only possible in space charge free devices. In this type, heating energy is supplied by a filament of tungsten, which is surrounded by a number of radiating vanes, which are, in turn, surrounded by several concentric cylinders of bright polished metal. The vanes are oxide coated, and the ends of the cylindrical structure are closed with the exception of holes for the entry of the heater filament leads at the one end and for the exit of electrons at the other. A large number of vanes can be packed into a given cylinder, and the area of the vanes decides the electron emission, but the heat loss is given by the temperature emissivity and area of the outermost heat shield. The area of this is small compared with the area of the electron-emitting vanes, and consequently a high efficiency is obtained.

Since it is essential that the peak anode current should not exceed the cathode total emission, it is clear that full load cannot be taken when starting up from cold. The cathode watts must be switched on and sufficient time allowed for the cathode to reach its lowest operating temperature before anode volts are applied. This time, known as the cathode delay time, varies with cathode design. A small directly heated cathode requires some 10 seconds, and the smallest indirectly heated cathode approximately 3 minutes. The large indirectly heated cathodes require from 10 to 30 minutes. The necessity for this delay is a disadvantage in some circuits, but is unavoidable.

The anode design is fairly straightforward, and does not greatly interest the user, but the grid design calls for attention.

It is necessary for the grid completely to shield the cathode, for a minute "leakage" of uncontrolled electrons will destroy the control action of the grid. This, however, is not, of course, the case with high-vacuum triodes, for in these an uncontrolled current of a few microamps is negligible. Furthermore, the grid must be in such a position that its temperature remains at well below an electron emitting temperature, for the current necessary to start the arc is only a few microamps, and since the grid potential is approximately that of the cathode in most circuits, these electrons are just as effective when emitted by the grid as when emitted by the filament.

The grid control ratio is determined by the relative spacing of grid to cathode and anode to cathode, and by the size of the holes or mesh of the grid, and can be given any desired value. Its actual value varies with temperature—because temperature affects mercury vapour pressure—and with individual tubes of the same type, owing to the necessity of manufacturing tolerances. Fortunately, it is possible to design the majority of circuits so that their behaviour is substantially independent of control ratio. The simple on and off control voltage magnitude control is affected by the value of the control ratio, and is unsatisfactory if a critical setting is attempted, but may be used if a comparatively large voltage change is available. If care is taken to apply a value of grid volts several times greater than the critical value for the particular anode voltage used, the phase shift method is practically independent of control ratio variation.

In one respect grid design is important, and that is in the time taken to de-ionise the space between anode and cathode after the arc has ceased, for until this space is de-ionised the grid cannot regain control. The upper limit of frequency at which a thyratron will operate is thus limited by de-ionisation time. De-ionisation occurs by positive ions flowing into the grid. It is largely affected by grid design and one branch of thyratron design work is concerned with this detail. At present de-ionisation times vary from 100–1000 micro-seconds.

The thyratron has many uses. It can serve as a quick-acting contactless relay that requires only a minute operating power, and it acts as an efficient rectifier of alternating current, with the magnitude of the A.C. output under smooth control. The thyratron may also be used in the inverse way, *i.e.*, to change direct current into alternating current, and it has many uses in the scientific laboratory. Its efficiency and unique properties may eventually give it a position of high importance in electrical engineering.

A Laboratory for the Mechanical Testing of Switchgear.

THE high cost of rupturing capacity tests on circuit breakers is, perhaps, not always fully appreciated. Approximately 25 per cent. of the cost of a "guaranteed breaker" is absorbed by research testing, but the tests are necessarily limited to a few breakers of each type. Although it is impracticable to subject every breaker to electrical short circuit capacity tests, every breaker should be tested in some manner to prove that it is electrically and mechanically sound. A routine test is essential to check against faulty material and workmanship. Cases have come to light where the routine test has revealed faulty castings, and, in some instances, faulty welding. Another reason for the necessity of routine pressure testing is that a weak container which is incapable of withstanding the maximum pressure developed under short circuit is a definite danger to life.

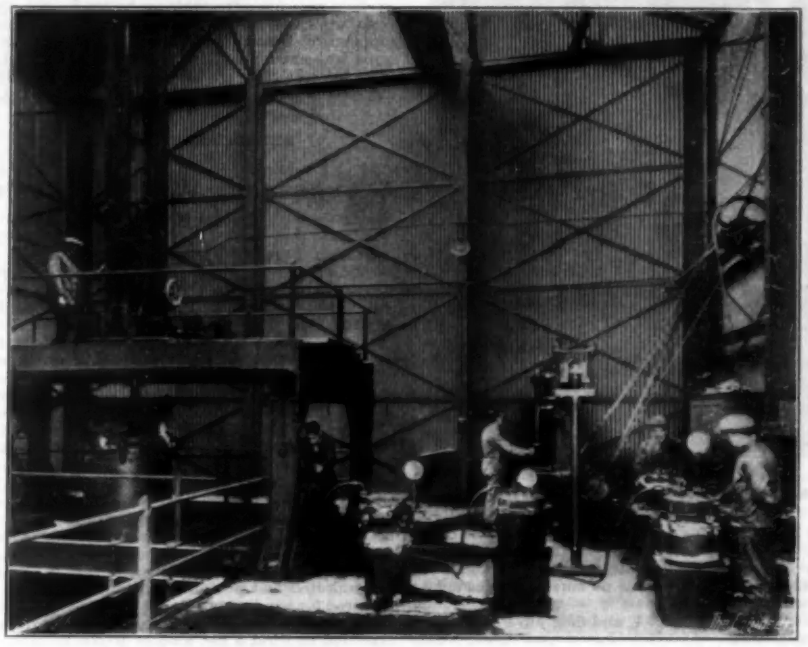


FIG. 1—SWITCHGEAR TESTING LABORATORY

The experience of Ferguson, Pailin, Ltd., has shown that the rectangular design of breaker has not stood up to short circuit capacity tests as effectively as the round tank design, and this has also been established by the firm's experience on routine pressure testing. To find the closest equivalent to an electrical short circuit test, the data obtained from thousands of actual tests has been examined. The pressure generated in a breaker when rupturing a given kVA short circuit may differ considerably over a series of tests, and it is only by examining the pressures produced over a large number of tests that the maximum pressures may be determined and a suitable margin of safety established. Although over a thousand

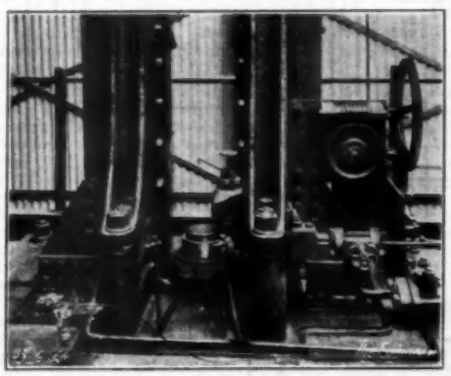


FIG. 2—IMPULSE TESTING MACHINE

rupturing tests up to 900,000 kVA have been carried out on the range of round tank breakers, the maximum pressure recorded did not exceed 300 lb. per square inch. The pressure-recording instrument employed when short-circuit testing Ferguson, Pailin breakers is capable of registering pressures at $^1/_{100}$th second intervals, and is, therefore, capable of recording both impulse and static pressures. The pressures generated under short circuit rise rapidly and may persist in the form of a series of impulses which gradually diminish in magnitude, or as a steadily falling pressure after the first impulse peak, as the gases are liberated through the vents.

The equivalent pressure test can be conveniently obtained by hydro-mechanical means, and Ferguson, Pailin, Ltd., have laid down extensive plant for carrying out these tests, a general view of the mechanical testing laboratory being shown in Fig. 1. Impulse pressures up to 2000 lb. per square inch and static pressures up to 1500 lb. per square inch can be obtained. The outstanding feature of the laboratory is the impulse testing machine—Fig. 2—which was specially designed and manufactured by Ferguson, Pailin for research purposes, and is believed to be the only one of its type in existence. The object of the impulse test is to reproduce by hydro-mechanical means those explosive stresses set up in an oil circuit breaker when operating under heavy short circuits. Besides testing the strength of the top plate and tank, this test also serves to show the behaviour of the joint between these members. A special gallery spanning a pit has been erected to support the machine, and breaker structures for test are placed on a travelling platform, which also spans the pit underneath the tester. Provision is made for the accommodation of breakers designed for pressures up to 220,000 volts, and, in addition to the impulse pressure tests, the pit is also used when testing breakers to destruction.

The broad principle of the impulse test is that a circuit breaker is filled with water, which is subjected to an impulse pressure by means of a weight dropped on a piston head from a predetermined height. The shock registered in the breaker is similar to that registered under an actual electrical short-circuit test. The falling weight slides in a cylinder connected by means of a steel tube to the top plate of the breaker undergoing test. A steel cap takes the blow on the plunger and may easily be replaced if damaged by the action of the falling weight. To reduce shock to the machine should the breaker burst, the cylinder can slide freely in the steel base and it is supported on two plungers resting on steel springs. Different sizes of falling weights may be utilised, depending upon the amount of energy required. When the falling weight has hit the plunger it is prevented from rebounding by means of catches, the shock of the rebound on these catches being absorbed by oil-filled dash-pots. To suit different sizes of weights, the catches may be arranged at any height by means of a duplicate hand wheel and worm drive mechanism, situated half-way up the column. The catch blocks are spring-loaded and may be withdrawn to allow the weight to be raised. Before the weight can be released electrically, an electrical interlock ensures that the catch blocks are in position.

All controls for the operation of the impulse test machine, which is shown ready for carrying out a test in Fig. 1, are located on the gallery, and by closing a switch mounted on the left-hand column, a solenoid is energised and opens a valve, thereby allowing water to flow into the breaker structure. The plunger is lifted by the water until it engages the pointed "firing" lever, shown in Fig. 2. The tripping of the firing lever closes the filling valves, makes the circuit of the solenoid, which releases the weight, and energises, through a separate pair of contacts, the pressure-recording apparatus.

In addition to the impulse pressure test machine, equipment is installed for the carrying out of routine static hydraulic tests. The principle of this test is that the breaker container is filled with water and the internal pressure raised to a value in excess of the actual pressures recorded under electrical short-circuit test on the breaker. Water is drawn from an accumulator outside the main building, and passes *viâ* the control valves, on the near stanchion of the impulse test gallery, through flexible pipes to the breakers undergoing test. Pressure is obtained from a plunger pump situated at the far right-hand corner of the building. For rapidly filling and emptying the breakers a reversible rotary pump has been installed.

A GRANT of £10,000 has been made by the Government to the National Polar Year Committee towards the cost of a British expedition to the Arctic. This expedition is part of an International Commission, and for about twelve months scientists from fourteen different countries will live within the Arctic Circle. Observation posts will be spread all round the magnetic pole. The principal British expedition will be led by Mr. J. H. Stagg, of the Meteorological Office, and there will be five other members of the party which will be equipped with the most modern apparatus for meteorological and other observations. The party will leave England about the end of May, and will continue its work until as late as possible in August, 1933.

An Electrode Boiler for Distilling Water.

For the purpose of distilling water at the works of the Milton Proprietary, Ltd., at Brewery-road, Islington, an electrode boiler has been installed by Bastian and Allen, Ltd., of 26, Cross-street, Essex-road, N. 1. It is rated at 30 kW, 200 volts, and it is working on a single-phase supply with one pole earthed. Owing to the long distance from the sub-station current is supplied through a 1–1 transformer to prevent any possibility of earth currents being registered. The primary of the transformer is controlled by an Ellison oil-immersed circuit breaker and the

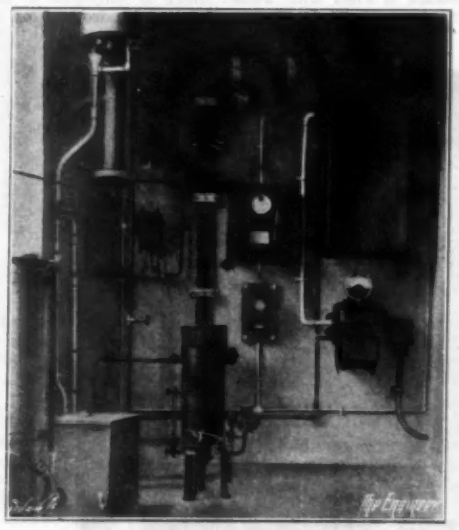


FIG. 1—ELECTRODE BOILER EQUIPMENT

secondary 200-volt mains are connected direct to the boiler terminals. The automatic electrical control for starting and stopping the plant is both neat and unusual, and the main switch is always left on, as no current passes unless there is water in the boiler.

The boiler is shown in Fig. 1, and diagram Fig. 2 shows the general scheme. At a set time a time clock, which controls the plant, closes a 60-volt circuit taken from a tapping on the secondary of the transformer to the small motor feed pump fixed to the boiler shell. Water is thereby pumped into the boiler and current begins to pass as soon as the water reaches the bottom of the electrodes. As the water level rises the current increases until it reaches the load previously set on the patented control panel seen above the boiler. It will be obvious that if current fluctuates according to the water level, by controlling this level the steam output is also controlled. When, therefore, the water reaches the level to give the load for which the boiler is set, an electro-magnetic relay is brought into operation which stops the pump, thus preventing any further increase in load. The level of the water then drops a little as more water is evaporated. This lowering of the water level slightly reduces the load until the relay goes out of operation, thus starting the pump again, and this process continues automatically.

The steam raised is taken to a still shown on the left of Fig. 1, where it is condensed in evaporating the still water. The condensate is returned to the boiler hotwell, from whence it is re-fed into the boiler. The still is of the indirect type, as the boiler evaporation is not used as the finished product, but fresh water taken through the still is vaporised by steam from the boiler, then condensed and drawn off into glass-lined containers. The necessity for this arrangement is to make certain that the finished product is absolutely pure and to take no risk whatever of any particles of oil from the steam finding their way into the distilled water. At the moment the switching on by the time clock occurs a motor-operated valve opens and allows water to pass through the still, and this valve is closed again by a float switch when the containers are full. The float switch also breaks the 60-volt circuit and stops the feed pump. The contents of the boiler are then quickly evaporated and the boiler automatically closed down.

Apart from setting the time clock and adjusting the load control, the plant requires no attention whatever, and not only can advantage be taken of any special night rates for electricity, but time can be conserved by procuring a full supply of distilled water overnight to meet the daily demand. Very little space is taken by the installation, and the boiler, which projects barely 18in. from the wall, is capable of producing 90 lb. of steam per hour at any working pressure adjustable up to 120 lb. per square inch.

As we have said, the electric boiler equipment was supplied by Bastian and Allen, Ltd., whilst the electrical work was carried out by Burdette and Co., Ltd., of 5, Pocock-street, Blackfriars, S.E. 1, under the direction of the consulting engineer, Mr. T. W. Ellis, of 70, Victoria-street, S.W. 1.

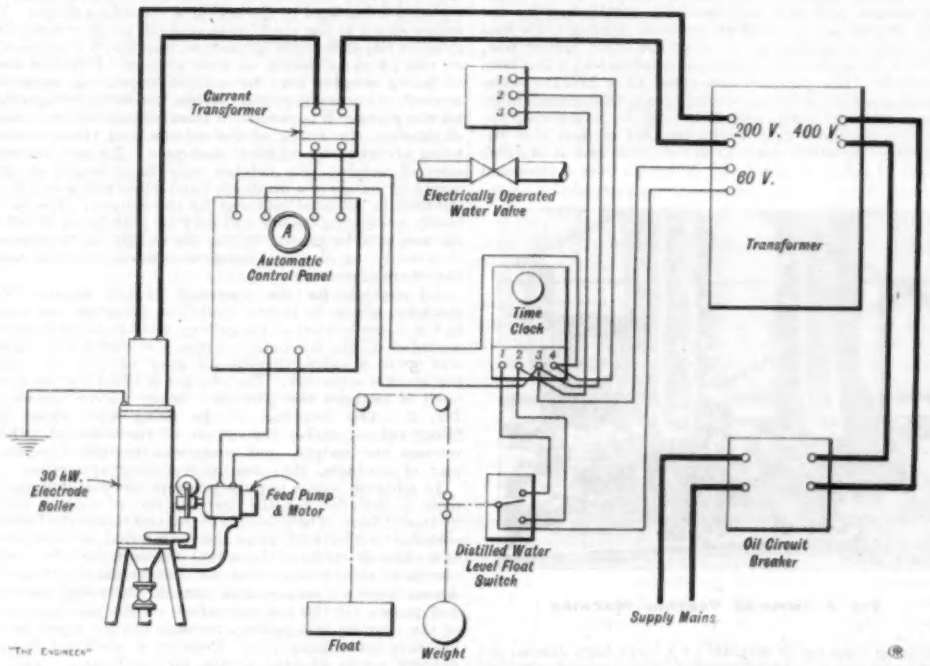


FIG. 2—DIAGRAMMATIC ARRANGEMENT OF ELECTRODE BOILER EQUIPMENT

A Compound Winding Engine for South Africa.

DURING a recent visit to the Chesterfield works of Markham and Co., Ltd., we examined a large winding engine destined for the gold mines of South Africa, which is of unusual interest. It is the subject of our illustration on page 368.

The peculiarity of this engine lies in the fact that it is of the compound condensing type, but is nevertheless to be used for hoisting men. It is, of course, generally considered that condensing engines should not be used for hoisting men, as, in the event of the vacuum in the condenser being accidentally lost, the only remaining chance of arresting a run-away cage lies in the main post brakes. A duplicate check is desired and can, of course, be provided in a simple non-condensing engine by using the reversing lever. In the case of the engine under review, however, the economies associated with compound condensing machinery have been coupled with a secondary braking system, which appears to us to meet the most stringent requirements. Nevertheless, it is of such a nature that it could be easily disconnected and put out of action should the engine be required for winding ore alone.

The engine is going to the Daggafontein Mines and is intended to wind a net load of 10,000 lb. from a vertical depth of 4200ft. at a maximum speed of 3500ft. per minute. In ordinary working, however, the speed for hoisting ore will be 3000ft. per minute, and when set for men 2600ft. per minute. The period of acceleration is estimated at 20 seconds.

Before going on to a general description of the engine it may be interesting to give some account of the special brake gear which has been provided for use when men are being hoisted. This gear can be seen plainly in the foreground of our half-tone engraving and is elucidated by the small line sketch.

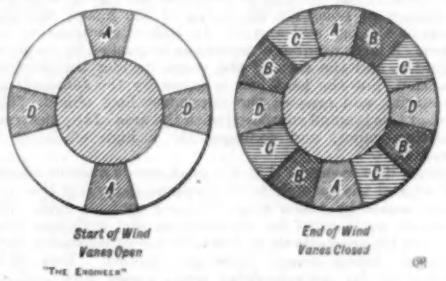
The engine, it will be observed, is of the twin tandem compound type and the tail-rods on each side are extended to pass through auxiliary cylinders in the rear. These cylinders are filled with oil and the tail-rods are provided with pistons made up of a series of star-shaped pieces A.B.C.D.—see sketch—which can be rotated relatively one to the other so that the spaces between the arms of the stars may be more or less obscured, until at the completion of the movement a virtually solid piston is provided.

It is obvious that with such a dashpot arrangement directly in line with the piston-rods of the engine, and consequently operative on the crank shaft, a most powerful instrument is provided for checking the cages in the case of a run-away. The dashpot cylinders are 16in. in diameter, and it is estimated that a pressure of about 400 lb. per square inch may be developed on either side of the star piston in the case of accident. There are, however, safety valves and pressure gauges for 500 lb. per square inch at either end of each cylinder.

The orientation of the stars of the pistons to provide more or less passageway for the oil, and consequently less or more retardation of the engine, is effected automatically. At the driver's stand there is a series of levers, which can be used to put into action three specially shaped cams labelled "Men Lowering," "Men Hoisting," and "Rock Hoisting." These cams are duplicated for forward and reverse running. The cams are connected with the main drum shaft and are so shaped that they come into action at the critical periods of a wind. These cams operate lay shafts, which can be plainly seen running along each side of the engine in the engraving. By means of a link motion these side rods can oscillate guide sleeves—in the extreme foreground—and consequently oscillate the extension of the tail-rods in the hydraulic cylinders to vary the star-shaped setting of the dashpot pistons. There is a ball-bearing thrust connection between the low-pressure tail-rod and the dashpot rod to allow for this oscillation. Naturally, only one of the cams used in this manœuvre is put into operation at one time, but the levers for the cams and the main throttle are so interconnected that the driver cannot make a false move. The dashpot cylinders are connected with the low-pressure cylinders of the engine by substantial distance pieces, but are free to expand under temperature influences, and are water-jacketed to take up any heat which may be generated when they are at work.

Reverting to the winder itself, it has double rope drums 11ft. in diameter by 8ft. 3in. wide, and, on either side, cylinders 25in. and 40in. in diameter by 60in. stroke, working at a pressure of about 140 lb. per square inch at the stop valve. It will be expected to handle, in balance, 4200ft. of 1¼in. wire rope, weighing 17,260 lb., a Humble hook of 300 lb., a skip of 10,200 lb., and a useful load of 10,000 lb. of ore.

The valve gear is a combination of the double-beat drop type on the inlet side with Corliss valves for the exhaust. Each cylinder is provided at each end with a balanced equilibrium valve and safety or relief valve, and the equilibrium valves are interconnected so that they are under the control of the driver. The reversing gear is actuated by a horizontal steam reversing engine, con-



HYDRAULIC BRAKE VALVE

trolled by an oil cataract cylinder, with the usual floating gear, so that movements of the handling lever work simultaneously with the position of the floating lever. It is noteworthy that all the shafts and levers of this gear are keyed together doubly, with keys at right angles.

The crank shaft has been so designed that it is interchangeable with those of other winders, by different makers, owned by the mine, and has a major diameter of 19in. with a central borehole of 4in. There is a central bearing between the two winding drums of 18in. diameter by 28in. length, and two other bearings, before the overhung disc cranks of 17in. by 30in. The crank pins are 10in. by 11in. and the front piston-rods 6¼in. in diameter.

The rope drums are free on the shaft, but may be clutched thereto by means of a toothed clutch, which slides on a hexagonal part of the shaft. This motion is effected by a steam cylinder and enables the relative position of the rope drum and the shaft to be adjusted by one foot of rope length for every tooth of the clutch. A large mirror is so arranged that the driver can properly see to manipulate the clutch without moving from his station. The drums have mild steel barrel plates 1½in. thick and are grooved to a depth of ¾in. at a pitch of 1 5/8in.

Besides the hydraulic brakes which we have already mentioned, there is an equipment of the usual form of post brakes acting on drums attached directly to the winding drums, and a set of brakes, operated by foot, that may be applied to the crank discs. The engine is provided with the usual form of disc depth indicators, driven directly off the cheeks of the rope drums, and with a Whitmore gear as a protection against overwinding.

ACCORDING to the *Iron Age*, the Electro Metallurgical Company, of New York, has developed a new series of steels containing chromium, manganese, and silicon. They are known as "Cromansil" steels and can be made in the open hearth at a nominal increase in cost over carbon steels and without changing the usual methods of manufacture. They can be forged and rolled like carbon steels. "Cromansil" steels in the as-rolled or heat-treated condition develop ultimate strengths from 29·0 to 60 tons per square inch, with yield points from 20·1 to 45·1 tons per square inch. Their fatigue limit is about 60 per cent. of their ultimate strength, and their ductility is much greater than that of any corresponding carbon steel or of alloy steels containing only two of the alloying elements. Their transverse and shearing strengths are relatively high for any given tensile strength. With simple heat treatment they develop tensile strengths up to 60 tons per square inch. "Cromansil" steels can be worked with ordinary shop tools and can be fabricated by all usual methods. They can be used in the as-rolled condition, can be heated for bending and forming without destroying their physical properties, and can be welded without hardening.

Railway and Road Matters.

In answer to a question addressed to him on March 17th, the Prime Minister said that he was not yet in a position to make a statement as to when it was proposed to proceed with the London Passenger Transport Bill.

With the introduction on and after to-day, April 1st, of an additional stop at Coventry to pick up passengers for Willesden and London, the 4.50 p.m. L.M.S. express from Birmingham (New-street) to Euston will be timed to cover the 88¾ miles from Coventry to Willesden in 87 minutes. This additional stop and consequent acceleration involves the maintenance of an average speed between Coventry and Willesden of 61·2 miles per hour. The train will still cover the 112¾ miles from Birmingham to Euston, with two intermediate stops, in two hours.

What are generally known as the Railway Returns form a sequel to the Regulation of Railways Act, 1868. The information contained therein was very much enlarged—beginning with those for 1913—as a consequence of the Railway Companies' (Accounts and Returns) Act, 1911, and have since been further increased by the inclusion of much of the information that the companies have now to send to the Ministry of Transport and which finds a place in the Ministry's monthly railway statistics, and independently of what they statutorily furnish in their annual reports. With this volume of figures the Railway Returns cannot readily appear before the autumn, and, therefore, as soon as the annual reports are available, the Ministry prepares, and the Stationery Office publish, a preliminary return. That for 1931 has just been published, price, post free, 7d.

We have more than once given the warning that any small increase, stationary character, or slight decrease in passenger train mileage is not representative of all the facts. Under that heading, all rail motors, Sentinel-Cammell coaches, internal combustion engine trains, &c., are placed on the same level as a fully staffed train, even although they require only a driver and a guard. Thus, Mr. Whitelaw, at the L.N.E.R. annual meeting on March 4th said: In order to put ourselves more nearly on an equality with the omnibus companies, we have introduced smaller units, such as the rail coach, where the circumstances are favourable, and have actually intensified the service in some cases in the hope of making it more popular. It may interest you to know that of the total coaching train mileage, amounting to 65 million train miles, no less than 2,300,000 train miles were run by rail coaches and similar small units.

According to the Board of Trade returns, the value of the railway material exported during the month of January last was as follows, the corresponding figures for 1931 and 1930 being added in parentheses:—Locomotives, £67,446 (£341,777, £346,327); rails, £31,594 (£55,741, £253,576); carriages £20,874 (£155,300, £137,227); wagons, £40,687 (£145,140, £294,279); tires and axles, £14,621 (£30,071, £59,898); wheels and axles, £1595 (£23,160, £26,123); chairs and metal sleepers, £36,554 (£4896, £66,583); miscellaneous permanent way, £19,382 (£39,870, £83,222); total permanent way, £104,222 (£164,083, £499,948). The weight of the rails exported was 3961 tons (6149 tons, 29,343 tons), and of the chairs and metal sleepers 4430 tons (335 tons, 6848 tons). Of the value of locomotives shipped last January there were: Straits Settlements, £14,375, and India, £10,400. Of the rails, there were:—India, £12,450; Portuguese East Africa, £8551; British West Africa, £6100; the Argentina, £957.

With the introduction last week of accelerations in freight services amounting to a total of 1910 minutes, the L.M.S. Railway announces the completion of a further stage in its programme of quickening merchandise transport—already worked in the majority of cases on the principle of one-day transits between important towns. Other accelerations effected during the early part of this year provided savings in time amounting to 642 minutes, so that in three months the L.M.S. has speeded up its freight services by 2552 minutes, a daily saving to traders in future of 42 hours 32 minutes. The principal services affected by the latest accelerations are those between Scotland and Manchester, Birmingham, and the West of England. In connection with this speed-up, several new express freight trains, fitted with continuous brakes, are being provided between Carlisle and Birmingham, and between Birmingham, Derby, and Carlisle, whence fresh engines will leave immediately with the traffic for Edinburgh and Glasgow. As an example, the accelerated service traffic from Aberdeen despatched on a Monday night is due to reach Gloucester and Bristol before breakfast-time on the Wednesday.

It is the sixtieth anniversary to-day of one of the outstanding events in British railway history. Up to April 1st, 1872, passengers at only first and second-class fares were conveyed during the day; third-class passengers had to travel by what were known as parliamentary trains; which, in effect, were one train in each direction daily. Those trains were so named as they were a statutory requirement under the Regulation of Railways Act, 1844. Much might be said as to the discomfort under which such travel was made, but all that was changed by the announcement, sixty years ago that from April 1st, 1872, the Midland Company would convey third-class passengers by all its trains. The new policy was exceedingly popular with the general public, and partisan writers called it a master-stroke. The other railway companies did not concur in that opinion, and looking back now it would seem as though Allport, in his concessions was somewhat premature, as the loading of the trains to meet the increased number of passengers added to the difficulties the companies were experiencing from the remarkable increase in traffic that set in after the Franco-Prussian War, *i.e.*, in the early 'seventies. As proof of this, we find Captain Tyler, in his annual report for 1873, saying: ". . . The experiment of conveying third-class passengers by fast non-stopping trains, as partially adopted, does not seem to have been entirely satisfactory, either to the railway companies generally or to the passengers of higher classes travelling by express trains, as leading, where duplicate trains have not been run, to overcrowding, unpunctuality, or other inconveniences."

Notes and Memoranda.

Volcanic dust, which is mined in Saskatchewan, is said to be finding favour among road engineers as an admixture with concrete and asphalt.

It is claimed that the George Washington Bridge across Turtle Creek, near Pittsburg, includes the largest concrete arch in the United States. The central arch has a span of 460ft.

It is claimed that the Home Insurance Building, in Chicago, is the first "skyscraper" ever built. It was erected in 1885, but is being pulled down to make room for a more modern building.

The Saskatchewan Power Commission now supplies electricity to 120 urban centres and owns and operates a total of 1321·5 miles of transmission lines within the Province, according to the annual report of the Commission. The Province's total investment in the system stands at 7,287,826 dollars, and an operating profit of 159,177 dollars is shown for 1931.

It is claimed that from 92 to 98 per cent. of the dust in the flue gases of the new power station at Michigan City are precipitated by the Cottrell electrical process. The plant comprises a 68,000 kW turbo-generator and three boilers, each having a furnace capacity of 14,700 cubic feet. They are fired with pulverised coal. The velocity of the gases through the precipitators is 8ft. per second, and the electrodes are charged at 75,000 volts.

In the course of a paper on "Production of Oil from Coal by Hydrogenation," read recently before the Cleveland Institution of Engineers, Mr. K. Gordon stated that a coal hydrogenation plant built on a scale to manufacture 200,000 tons per annum of petrol would cost about £8,000,000. This figure includes land, development charges, interest during construction, hydrogen plant, boilers, power stations, water supply, offices, roads, stores and workshops, and provision for working capital. The operating cost was 7d. per gallon, including provision for obsolescence. Both the capital and operating costs, neglecting the cost of the raw material, for tar and oil hydrogenation were less than for coal, because of the reduced quantity of hydrogen and the greater throughput possible.

Among the rarer metals which are light in weight and therefore suggest themselves for employment in the aircraft and automobile industries, beryllium stands out prominently. It is lighter than aluminium and has a much higher melting point than either aluminium or magnesium. In order to provide authoritative information about beryllium and the distribution of deposits of beryl—the only source of which adequate supplies are available—a useful little monograph has been prepared by the Mineral Resources Department of the Imperial Institute. At present the metal is being produced commercially only in Germany and the United States. However, it is clear from the details provided that the British Empire is in a strong position to exploit its resources of beryl if adequate financial help can be found to follow up the preliminary work already accomplished in the field and laboratory.

In a short editorial article in the *Chemical Trade Journal* it is said that "With the help of the new synthetic resin products the old-established oil varnish industry looks like maintaining more effective competition against the newer cellulose lacquers than was at one time thought possible. The ease of application of the latter materials, particularly their capacity of being readily applied by means of the spraying method, and their specific properties, will always ensure for them a wide field of utilisation; the statistics so far available show no evidence of any falling off in the rate of augmentation in the industrial utilisation of cellulose lacquers since their introduction on the market in bulk. At the same time the advantages as to high gloss and hardness of finish which the cellulose lacquers have maintained over the oil varnishes are disappearing with the availability of the synthetic resin incorporants for these latter, both of the phenol-formaldehyde and of the glyptal types."

The importance of choosing the wood used in the construction of motor cars appropriately to the climate of the country where they will be used is pointed out by C. H. Humphrey in the *Philippine Journal of Science*. He states that the depreciation of imported automobiles in the Tropics from this cause reaches "a staggering figure in proportion to the investment." Most of the cars in the Philippines are American, a few come from Europe; in either case the woods used in their construction are almost exclusively temperate zone species, selected for other properties than their durability. The decay sets in as the result of moisture in the wood, but, under the conditions in the Tropics in the rainy season, water almost inevitably penetrates and, in the humid atmosphere, does not easily dry out again. The author states that "six months under test conditions very highly favourable for decay will destroy for all practical use nearly all the temperate zone woods now used in American or European-made cars."

Many journals—we, ourselves, are incriminated—have the habit of re-telling stories of the past. And they are not infrequently interesting; but those of our contemporary *Nature*, which deal just now with geographical exploration, are especially fascinating, as they have a direct bearing on the development of this earth by engineering means. Here is a quotation from the column we have in mind: "Vancouver meticulously surveyed the labyrinth of channels [in the region of St. Juan de Fuca, on the Pacific Coast], determined to leave unexplored no portion of the coast-line which might conceal a possible outlet to the Atlantic. He thus proved that no strait leading across to Hudson Bay could exist in these latitudes. The Columbia River was explored for 84 miles from its mouth. The 'Discovery' arrived in the Thames on October 20th, 1795, after her four and a-half years' voyage, during which only one man of the crews of the two vessels died of disease. This arduous, prolonged, and detailed survey of the Western Coast of America is one of the most remarkable feats of exploration. It attracted little attention at the time, partly because it was scientific rather than spectacular in character, and partly because Vancouver sought no publicity."

Miscellanea.

Canadian-made sulphate of ammonia is being exported to China, the Dutch Indies, and to Hawaii.

The Kobe Steel Works, in Japan, intends to double its output of wire rods. It will then produce over 10,000 tons a month.

The Air Ministry has, after exhaustive trials, purchased an amphibian aeroplane built by the firm of Saunders-Roe, of Cowes.

An oil refinery is to be put up at Vancouver by the Shell Company, and it will probably be followed by another in Ontario.

A dredger for service in Leningrad Harbour is to be be built by Lobnitz and Co., of Renfrew. The contract price is some £100,000.

The Leeds Corporation Highways Committee is considering an offer for an experiment with cast iron blocks for road construction.

A factory for the production of duplicating machines and allied appliances is to be put up in Toronto by the A. B. Dick Company, of Chicago.

It is announced that a big bridge is to be built across the Brisbane River, New South Wales, and that the tender of Dorman, Long and Co. will probably be accepted.

The recent extensions of the galvanising plant of the Tata Iron and Steel Company, at Jamshedpur, will, it is said, enable the company to supply over 40 per cent. of India's requirements for galvanised sheets at the present rate of consumption.

At a meeting held at St. Austell, Cornwall, on March 18th, at which representatives of almost all the china clay producing companies were present it was unanimously decided immediately to form an association representative of the British china clay producers.

In Kazakstan, Russia, deposits of quartzite have been found which, it is said, can replace acid-resisting bricks imported from abroad. The reserves of quartzite are, says the *British Russian Gazette*, sufficient to cover one-third of the industrial needs of the Soviet Union.

In his remarks at the annual meeting of the Grand Union Canal Company, the chairman, Mr. W. H. Curtiss, said that in 1930 the traffic on all the canals of the country amounted to 13,235,784 tons, but that was only about one-fifth of their capacity if they were properly brought up to date.

Work has been started on a large terminal storage plant for the McColl-Frontenac Oil Company in East Windsor, Ontario. The site is 5 acres in extent, and there will be three large storage tanks with warehouses and offices. The company has leased river dockage, and will pipe the supplies from the river to the new plant, which is near the Père Marquette Railway.

The largest pumping plant in the New York City water supply system which, it is believed, will avert future water shortages, was set in operation March 15th. The new plant, on the south shore of Croton Lake, is expected to stop the annual loss of 20,000,000,000 gallons of water over the spillway of the Croton Dam. Its capacity is 180,000,000 gallons a day, drawing water from Croton Lake, and delivering it into the Catskill Aqueduct at a point 170ft. above the high-water level of the lake.

According to the *Iron and Coal Trades Review*, the Gutehoffnungshütte of Oberhausen, one of the companies belonging to the Haniel Combine, has signed a contract with the Chinese National Government for the erection of works in the neighbourhood of Nanking for the production of pig iron and rolled iron and steel. The necessary capital for the venture is to be loaned to the Chinese Government by the Haniel Combine, the money being repayable in instalments. Building will not be started until normal conditions in China are restored.

The two new main line sections of the Great Western Railway at Westbury and Frome are expected to be ready by the end of June, and will provide by-pass rail roads over which will operate the main line expresses, boat expresses, ocean mail trains and express freight and perishable trains. The quadrupling of 21¾ miles of line at congested points at Taunton, Bristol, Cardiff and Olton, and the conversion of thirteen stations in the Taunton, Bristol and Swindon areas into four-line stations, are expected to be finished by the end of 1935.

It may be of interest to note, says the *South African Mining and Engineering Journal*, that iron ore for the blast-furnace at Pretoria, which is now approaching completion, will come from two sources:—the Pretoria siliceous hematite containing about 48 per cent. iron and up to 21 per cent. silica, and a very pure hematite from the Vliegpoort district which contains up to 68 per cent. iron and very little silica. As the Vliegpoort ore is too pure to be smelted alone, sufficient of the Pretoria siliceous ore will be mixed with it to produce the necessary slag volume.

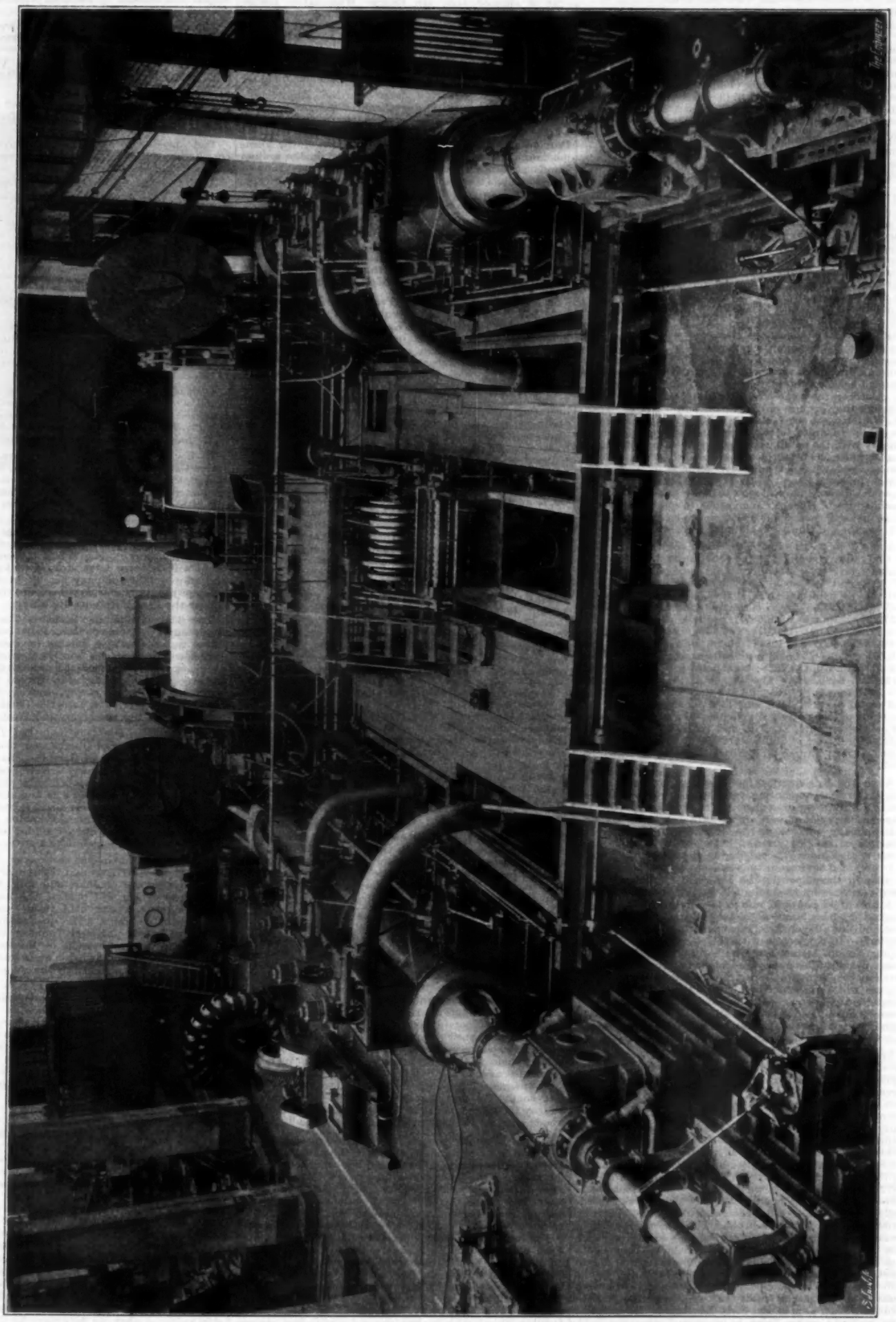
Presiding at the general meeting of D. Napier and Son, Ltd., at Acton, Sir Harry Brittain, after referring to the important research, experimental, and development work being carried out by the firm on several new types of aero engines, said that in accordance with the broader policy adopted by the board, arrangements were being made for the re-entry of the company into the motor car business. Steps were being taken so that the company might be able to produce a car of first-class performance, reliability, and engineering merit. The company produced motor cars from 1899 until a few years back.

It is announced by Mr. Isaac Foot, M.P., Secretary for Mines, that a General Conference on Safety in Mines, representative of all those engaged in the coal-mining industry in the Midland and Southern Inspection Division and North Staffordshire, will be held under his chairmanship at Birmingham on Saturday, April 30th, from 11 a.m. to 5 p.m. Addresses will be given by Sir Henry Walker, C.B.E., LL.D., H.M. Chief Inspector of Mines; Mr. W. E. T. Hartley, H.M. Divisional Inspector of Mines; Professor R. V. Wheeler, D.Sc., Director of the Research Stations under the Safety in Mines Research Board, and Major H. M. Hudspeth, D.S.O., M.C., M.Sc., Mining Engineer to the Safety in Mines Research Board.

COMPOUND WINDING ENGINE FOR SOUTH AFRICA

MARKHAM AND CO., LTD., CHESTERFIELD, ENGINEERS

(For description see page 366)



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NOTICES TO READERS.

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RIVAL SYSTEMS OF SHIP PROPULSION.

WE fear it must be admitted that the long and earnest discussion at the Institution of Naval Architects upon Mr. Johnson's paper has not taken the question of fuel at sea much further. The protagonists of the rival systems, solid and pulverised coal and oil-fired boilers, oil engines, and electric transmission, all said their familiar says, the principal struggle, as usual, centering round the use of steam or marine oil engines. We are reminded by the inefficacy of the repeated discussions on this subject of an episode in the Calcutta rugby match at Twickenham, as given in the wireless commentary. The commentator said: "So and so is putting the ball into the scrum on the blind side. It's out again. He is putting it in again. It's out again." Not until the fifth effort was the ball fairly placed. So it seems to be with this problem. It is continually being put in—on the blind side?—and as frequently kicked out again, and no one seems to be a penny the better. We must regard it as fortunate that the game is not stopped whilst these vain efforts to get the ball into the scrum—that is, to get the problem fairly and simply stated—are in progress. Whilst the redundant debates go on, the shipowner and the engineer build better and better ships for propulsion by one method or the other. The problem is being settled not in the debating room, but on the high seas.

Resisting the temptation to juggle with the multifarious details which are adduced at every discussion on this subject, and result rather in the confusion than the enlightenment of the anxious engineer, we are led to the perfectly obvious conclusion that there is no best way of propelling ships, and no engine-room arrangement which is superior to all others. Every one of the systems in present use has its particular advantages and the defects of its merits. Each of the disputants by accentuating the advantages of the system which he prefers and enlarging upon the weaknesses of the systems advocated by his opponents, can present an excellent case. But when all the rivals have advanced their arguments, it is found that they cancel out and that the shipowner has before him a choice of methods of propulsion from which he must select that which is best suited to the conditions and service for which his vessels are designed. His choice will, in the majority of cases, be influenced relatively slightly by technical engineering questions, but largely by problems which may be roundly described as "economic." No one, for example, can challenge the wisdom of using oil fuel in a large passenger liner or a tanker, or deny that the ready availability of coaling stations may render the employment of coal preferable on certain routes. Again, no owner would think of putting an extra-high-pressure steam plant into tramp steamers for the sake of the saving in fuel attainable. He would recognise that for such ships simple main engines are desirable, and he would be led, according to circumstances, to order either the familiar reciprocating engines and Scotch boilers, which any "first" might be trusted to handle, or steam turbines and water-tube boilers if he was confident of the ability of his engine-room staffs. His choice of oil or coal firing would be effected by the route the ships were designed to follow, but he might be grateful if he could at a few hours' notice switch over from one to the other. If he found himself torn between the respective claims of steam and oil engines, he would not only have to consider the qualities of the men who would work the ships, the cost and the availability of fuel, but the ability of the service to repay the probable extra expenditure in capital and insurance. Such things as these, which we have barely adumbrated, are manifest; they carry far more weight with the shipowner than the relative thermal efficiencies of rival systems. In exceptional ships, like large liners, the choice of the system of propulsion turns generally upon questions of a slightly different order. In passenger vessels, absence of noise, vibration, and dirt are important, and in ships of war the advantages of oil fuel are so great as to outweigh all other considerations. It is possible that in time the use of pulverised fuel at sea will be brought to perfection, and it may then win its way on its merits. We must be permitted to doubt, however, that commercial shipowners—and even the Admiralty—will ever be greatly influenced by the propaganda to use a native fuel. Even in these strongly national days, commerce will not, and cannot, accept a handicap which reduces its competitive power. Only where coal is equally convenient and no more costly than oil, will it enjoy the patronage of patriotism.

Whilst we are driven to the conclusion that there is no clear issue from these frequent debates on ship propulsion, we recognise that they have not inconsiderable technical value. It is impossible to believe that everyone of the protagonists is not aware of the advances made by his opponents, but there is, we think, little doubt that such open discussions as that on Mr. Johnson's paper, spur all parties to ever greater efforts. We may be thankful, indeed, that rationalisation has not yet been allowed to stamp out the rivalry of contending systems. The world is profiting by the continual emulation which is going on, and if the poor shipowner is sometimes embarassed by the urgency of rival claims and the number of competitive designs, he may yet congratulate himself on the fact that the conflict is having the result of making all systems of propulsion better than they were. It is bringing them all, from a technical point of view, so close together that in making his choice between them he may be safely ruled only by the particular conditions and characteristics of the services for which his ships are intended.

Railway Electrification in France.

THE Superior Council of Public Works in France has prepared a plan of railway electrification which is to be put in hand this year, and is expected to be completed within the next decade. It is a continuation of the plan that was elaborated in 1920 at a time when electrification was believed to cure all economic ills and effect a considerable national saving in the purchase of foreign coal. Six years later the programme was suspended through financial difficulties and also for reasons of prudence. Experience was deemed necessary before proceeding with it further, and it was found desirable to modify the original plans. Instead of primarily electrifying lines with difficult gradients, it was seen that more immediate financial gain would be derived from equipping the railways for express traffic, and that has been done on the Paris–Orleans and Midi systems, the only difficult section being the P.L.M. line between Chambéry and Modane. At present about 1000 miles of railway have been electrified, comprising 750 miles on the Midi, 141 miles on the Paris–Orleans, and 70 miles on the P.L.M., while the State Railways have 55 miles of electrified lines in the Paris suburbs. The new instalment of the programme provides for the electrification of an additional 1860 miles of railway. This includes the completion of the Paris–Orleans line to Bordeaux and the electrification of lines from Paris to Havre, Chalon, Dijon, and Le Mans. The Est line is thus brought within the scheme, contrary to the original decision that, for strategical reasons, it was undesirable to electrify railways serving the north-eastern frontier.

The railway companies had nothing to do with the original plan which was prepared by the then Minister of Public Works, Monsieur Le Trocquer, with a view to utilising all the available sources of energy in France. The claims in favour of the railway transformation appeared unanswerable, because no one knew what the hydro-electric energy would cost or what developments would take place in the future. Electrification was begun on the Paris–Orleans and Midi lines which traverse regions where the hydraulic resources are vast and easily controlled. They have practically unlimited hydraulic energy at hand, which is obviously cheaper and more convenient than coal brought from long distances. It is cheap because the cost is reduced by supplying to Paris and the south-west of France one-half of the energy available from the plants in the Massif Central and the Pyrenees. In the case of other railways, which would be dependent upon outside supplies of electrical energy, the conditions offer many elements of uncertainty. The plan of Monsieur Le Trocquer was based upon a presumably higher speed with electric than steam traction, and it did not take into account possible developments of the steam locomotive. High speeds have been obtained with the electric locomotive, but the speeds actually employed are easily surpassed by those of existing steam locomotives. French engineers do not believe that the steam locomotive has reached anywhere near finality, and until that stage has been attained there is obviously a risk in pushing forward a general scheme of railway electrification. In introducing the plan for the electrical equipment of railways in France, there was no suggestion that steam traction had failed. The troubles that subsequently befel railways arose from some causes that were particular to different countries, and from others that were general to all; electricity, it is held, will not save railways that failed financially when worked with steam. French engineers are well aware that a reorganisation of the railways must be carried out by means that will provide the necessary flexibility in operation, and there is nothing yet to show that electricity will, in all cases, prove more suitable for the purpose than the steam locomotive.

Whilst the electrification of French railways will come nearer realisation when the national scheme of electrical distribution is completed by connecting up the hydro-electric system in the south with power stations at collieries in the north, thus providing a regular and reliable interdependent supply of current, France is as conscious of other factors which enter into the operation of railways as is Great Britain. She, also, is watching with interest the development of the oil locomotive, the progress of which in recent years has introduced a new element into a complicated and difficult problem.

Institution Discussions.

A CORRESPONDENT has raised, once more, the question of the value of the discussions at technical meetings. It is good that it should be aired occasionally, for it is only by the discussion of discussions that improvement is likely to be attained. Our correspondent appears to object to what we believe THE ENGINEER was the first to call the "stage-management of discussions," but if he can throw his mind back to the time when the President had to rely upon a supply of casual speakers he will, we think, agree that it is better to have a list to draw upon than to run the risk of the total failures which were not uncommon in those days. The defects of the system are outweighed by its merits. The greatest trouble is the necessity of limiting the time which can be given to each speaker. Our correspondent suggests adjournment of the discussion. That is frequently done by all institutions, but is rarely an unqualified success; it will be noticed that the attendance at adjourned meetings is always relatively small. The alternative is a discussion of indeterminate length. It means beginning the meeting at an inconvenient hour

and carrying it on till it dies out, or the chairman judges that the members are getting tired of it. If all speakers were effective, long debates would not be unwelcome. Unfortunately, many of them are quite the reverse. Their knowledge may be great; their powers of presentation are small. On the relative merit of reading papers in full or in abstract, there will always be differences of opinion. Some authors abstract skilfully. Mr. Robinson, for example, covered his whole subject adequately in about half an hour, and kept the attention of his audience alive; but he was concentrating on a single issue and that, we suggest, gives a useful clue. Are papers too comprehensive? Is it not better when an evening debate is in view to limit them to one or two matters, preferably those of a debatable kind? It would be possible to reply definitely in the affirmative if the spoken discussion alone had to be considered. That is far from being the case. The printed "Proceedings" of all institutions reach many times the number of members who attend the meetings, and their value as a source of information has to be very carefully weighed. In any further correspondence on this matter we hope that this fact will be borne in mind.

Machinery Imports into France.

The system of import restrictions as applied by the French Government is causing so much prejudice to foreign manufacturers, and is creating so many complications, that it will have to be modified if the French really desire to avoid an entire disorganisation of foreign exchanges. The quotas are usually published, without previous warning, two or three weeks after the date upon which they are put into operation, and foreign makers may, therefore, find that they are prevented from executing orders, while importers are greatly embarrassed when taking orders from French customers. The system may be justified to a certain extent as a means of protecting home industries and of putting a check on dumping; but its application is arbitrary and unfair. The recent quotas of textile machinery imports affected so seriously the interests of British manufacturers that the British Chamber of Commerce in Paris has made representations to the French Minister of Commerce, who has promised to consider the situation of British makers, for which purpose he has requested the Chamber of Commerce to prepare for him a full statement of its case. The quotas are fixed by French manufacturers themselves, who are supposed to negotiate with foreign makers for a limitation of imports in a way that will be as fair as possible to all concerned. The results so far have been disappointing. The machine tool quotas, which are so entirely favourable to Germany, followed upon negotiations between French and German manufacturers, because there was more danger of competition from Germany than from other countries. The influx of German machines into France at low prices has been arrested by granting to German firms a high quota at the expense of makers elsewhere. American manufacturers have protested strongly against an allotment of quotas which they regard as unfair, and some French buyers of machine tools have expressed the fear that this method of suppressing competition will be detrimental to the national interest. It is true that the decree provides for special import licences for machines that are not manufactured in France, but that does not alter the discriminating character of the quotas as they are applied at the present time.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE POSITION OF THE OIL LOCOMOTIVE.

Sir,—I should like to express my appreciation of your very sympathetic discussion in your March 11th issue of my letter which you published the previous week.

While you have expressed sympathy with the internal combustion locomotive, you challenge certain of my statements, and as I believe that your doubts can be removed, I would crave the further use of your space to this end.

It is of interest to note that in quoting paragraph 31 on page 12 of the Weir Report, you draw attention to the strong predisposition towards electrification shown by the Committee throughout its report. Indeed, the terms of reference of this Committee obviously did not permit of any full investigation of any alternative to electrification, and there is no evidence in the report that oil-engined units received anything but a cursory mention in the terms which you quoted.

Certainly had their terms of reference permitted them to make the same detailed investigation and to call equivalent expert evidence, they must have arrived at a very different conclusion. Meantime, the railways have by no means accepted this dictum of the Weir Committee, and are carrying their active investigation of the claims of the oil engine far beyond the limits of lightly loaded branch lines.

You next go on to query my comparison of the oil-electric with the all-electric tractor, and suggest that my case falls to the ground because the presence of the oil engine so increases the time spent in repairs that my estimate of 30 per cent. fewer tractors is no longer tenable. In reply, I would point out that you have misinterpreted the figures I quoted, and in your favour I must admit that the quotation of a few figures when divorced from the full context is apt to lead to confusion.

The calculation of oil engine fuel consumption is not dependent upon the total number of locomotives owned by the railways, but upon the number actually running, and your reference to locomotives under repair in this connection is beside the point. The number of watt hours of electric power required for given services—suitably modified to account for differences in train weight, auxiliary power, &c.—is the same whether that power is supplied by engines on the train or from track conductors, and it is therefore reasonably correct to use the Weir Committee's estimate of power as the basis for fuel oil consumption. (The engine is stopped when power is not required, as when coasting, and does not consume fuel.)

In referring to capital cost, I said that the numbers would be *practically* the same, and if you will refer to the original figures which were widely published in the technical Press soon after the appearance of the Weir Committee's report, you will find that allowance was made in the capital estimate for a larger number of oil-electrics than all-electrics under repair, and that the figure taken for repairs cost was considerably in excess of that assumed by the Weir Committee for all-electric.

In this connection, however, you should note that a great deal of control apparatus essential to the all-electric is eliminated on the oil-electric by the use of voltage control of the engine-driven generator. This to some extent offsets the maintenance of the oil engine itself. You should also remember that the maintenance of sub-station and trackwork is chargeable against the all-electric locomotive.

From a study of the above, in conjunction with the original figures, I think you will agree that my estimates with not require the wholesale revision which you suggest.

You next suggest that to base figures on the complete replacement of the steam locomotive by the oil-electric is beyond the bounds of contemplation. In the first instance, I would point out that the figures quoted were produced as a reply to the Weir Committee's report and, being based upon the assumptions contained in that report, were of necessity drawn up upon the same basis. I would suggest, however, that there is considerably more justification for considering the complete replacement of the steam locomotive by oil-electric than by all-electric. It is a recognised fact that the all-electric system is not economical where traffic is light and the Weir Committee showed that it is not economical where inter-running with steam locomotives is required. On the other hand, the oil-electric system is economical where the traffic is light, and it is not affected by inter-running with any other kind of traction.

It is therefore evident that a partial change over by oil-electrification of those services showing greatest savings would show a considerably greater return than a complete change over. This is the direct opposite of the effect of partial electrification, suburban electrification being excepted. Further the estimates quoted show so large a return on capital expenditure that a complete change over to oil-electric is financially justified, whereas even the complete change over to all-electric was obviously not. The oil-electric has the further advantage that it is unnecessary to lay out huge sums of money on long term contracts. The change over to oil-electric can take place year by year, those steam locomotives being replaced which are due for normal replacement, and each step being economically justifiable and not dependent upon the completion of a huge scheme. Should there be modifications during the change-over period by the progress of events, such modifications can readily be introduced, which is not the case with electrification.

With regard to the speed of the larger experimental locomotives built, it is surely obvious that a start should be made on the slow speed freight locomotives, which do not entail the running gear complications of the higher-speed locomotive. So far as the Diesel engine is concerned, its operation with electric transmission is precisely the same whatever the speed of the locomotive. High-speed electric locomotives are now in general service, and once the application of the Diesel engine to the freight locomotive is perfected, it is only a step to apply it to the high-speed electric locomotive. As I pointed out in my previous letter, that step could be taken immediately were it not for the fact that it is essential for the railway staff to gain experience with the less important types before they could obtain reliable operation on the important passenger trains.

In this connection, I think that you have been unfair in divorcing my statement in this respect from the full context. My admission with regard to the fast express trains was definitely qualified by this question of training of railway staff, and was not the unqualified admission which you have made it. The full statement was as follows:—

> "With regard to general main line operation, I quite admit that it would be folly to attempt to introduce oil-engined locomotives for the fast express trains in this country at the present moment. It will be necessary for the railway companies to have at least two or three years' experience in the maintenance and operation of the oil-engined type on the less important trains before they would be able to maintain the locomotive to the degree of reliability at present obtained with steam."

Apart from this question of maintenance, we are as able to build a locomotive running at 70 miles per hour as to build one running at 30 miles an hour, and I would point out the fact that the four 1700 B.H.P. units for the Buenos Aires Great Southern Railway, at present being manufactured in this country, each have maximum speeds in excess of 70 miles an hour.

In conclusion, I would like to remove the suggestion that I am in any way attempting to criticise the management or engineers of the British railways. As you say, they are all profoundly interested in this new type of traction. That they must go step by step is obvious, and my only object in writing these letters has been to remove an impression which might have been created by your criticism of the final result which they hope will be eventually obtained.

Surely, the fact that the railway companies are taking this active interest is sufficient reply to the ill-informed critics, who imagine that the railway companies can change-over to a more economical haulage system overnight, and at whom your original remarks were levelled.

C. J. Hyde Trutch.

London, S.W. 1, March 23rd.

[In our Leading Article of March 11th we expressed the belief that there is not a great divergence between Mr. Trutch's views and our own. Mr. Trutch's present letter puts us on converging lines. We now leave the prosecution of the discussion to our readers.—Ed. The E.]

Sir,—Far from clearing up any misleading statements, Mr. Coleman's letter in your last issue only serves to confuse the matter. Indeed, I fear that he reads his Engineer only when in an imaginative frame of mind. Putting aside his mis-statement as to the heading of the article in question, I have looked in vain for the figure of £1065 for annual repairs with which he credits me; in fact, I cannot even find mention of the Illinois Central Railroad at all!

My brief mention of the broken crank shafts of the Ingersoll-Rand engines was qualified by a distinct statement that "on the whole the engines have proved satisfactory." How could he construe this into an inference of considerable trouble?

As regards the New York Central freight locomotive, the thanks of all are due to Mr. Coleman for proclaiming, in clarion tones, that the engineers responsible for the design of the engine have recognised their initial mistake. For, since they provided piston cooling, and so reduced the time and money spent on engine repairs, the annual mileage has gone up from 4000 to 10,600!

The observations upon which I based my own statements were made on the spot in America, and they have the advantage of being made by one who has no furrow to plough.

The Writer of the Article.

Blackheath, S.E. 3, March 28th.

JOHN HENRY HAMILTON.

Sir,—I have read with interest several letters in your current issue regarding the late Mr. J. H. Hamilton, and should like, if I may, to put on record some facts about his work.

In 1908, whilst serving my time with the Premier Gas Engine Company, I was sent by Mr. Hamilton to assist in running the 2000 H.P. gas-driven blowing engine, which was then running its acceptance test at the works of Alfred Hickman and Co., Ltd., of Bilston, Staffs.

This engine, designed and built by Mr. Hamilton, was, I believe, at that time, the largest internal combustion engine in the country. It was of the horizontal type, with four single-acting cylinders, arranged tandem in two lines. The rear pistons were attached to piston-rods passing through stuffing-boxes in the front cylinder covers. The blowing cylinders were double-acting and mounted vertically above the crank shaft.

The dimensions of the engine were as follows:—

Two front cylinders	39in. bore
Two rear cylinders	38in. bore
Piston-rods	6in. dia.
Two blowing cylinders	78in. bore
Common stroke	48in.
Maximum speed	94 revs.

The acceptance test was an unusually severe one and bears witness to Mr. Hamilton's faith in his engines. It consisted of eight weeks' full-load run, day and night, week-days and Sundays. We were allowed to stop for six hours every second Sunday to clean the gas-mixing valves. The blast-furnace gas on which the engine ran was so dirty that after this period the ports in the valves were choked almost solid with dirt, so that the power of the engine began to fall off towards the end of the fortnight.

Considering the size of the engine and the conditions under which it had to run, it gave remarkably little trouble. We should soon have got it through the acceptance test had it not been for trouble with the blowing cylinders. In the design of these Mr. Hamilton's lack of experience led him into several errors, which caused us much trouble, although eventually it was overcome, and the engine did its acceptance run without a hitch—a truly remarkable performance.

To illustrate the difficulties under which the engine

had to work, it may be said that there were no force-feed lubricators, and it was frequently necessary to supplement the gravity lubrication with a hand syringe. The cooling water was so hard that the passages in the water-cooled exhaust valves often scaled up so as to stop the flow of water altogether. It was then necessary to pour hydrochloric acid through the valves to clear away the scale while the engine was running. It was also sometimes necessary while the engine was running to tighten the glands on the swinging links that conveyed the cooling water to the pistons.

The engine worked on Mr. Hamilton's positive scavenge principle, the necessary air being taken from the blowing cylinders. Ignition was on the low-tension system with moving points inside the cylinder. There were two ignition plugs per cylinder, either of which could be cut out at will and removed for cleaning and adjustment without stopping the engine. This feature undoubtedly contributed largely to the success of the engine, as ignition at that time was the weakest part of large gas engines.

Besides the above described engine, the station at that time contained :

Three 500 H.P. Premier engines, driving direct-coupled generators.
Three 400 H.P. Premier engines, driving generators by rope.
One 1000 H.P. Premier blowing engine.
One 700 H.P. Cockeril blowing engine.
One 500 H.P. Crossley blowing engine.

When I visited the station again a few years later, the plant had been increased by the addition of :

One 500 H.P. Premier engine, direct-coupled to a generator.
One 2000 H.P. Premier blowing engine.
Three 1000 H.P. Premier engines, driving ammonia compressors for the production of dry blast by the refrigeration process.

Most of these engines ran almost continuously at nearly full load.

What finer monument could any engineer desire than such a station ?

One must not omit to pay tribute, too, to the courage and foresight of Messrs. Alfred Hickman in installing such plant.

W. A. GREEN.

Acton, W. 3, March 22nd.

BRITISH AND AMERICAN ROLLED STEEL STANDARDS.

SIR,—With reference to the article on British and American rolled steel beams, by Mr. B. L. Hurst, appearing in your issue of February 5th. In making his comparison with the so-called American "standard" beams and neglecting to give comparisons with the broad flange beams now in general use throughout U.S.A., Mr. Hurst gives your readers quite an erroneous view of the actual position. Indeed, most British readers would think our own standard beams could not be improved, when, unfortunately, this is far from being the case.

Actually, these American broad flange beams have a much larger usage than the American standard beams, a fact Mr. Hurst does not seem to be aware of. These beams, rolled in a four-way mill, are more efficient than any of the ordinary types of beam, either British standard or American standard, as these few examples will show :—

British section.	*American broad flange beam.*
24×7½×90, S.M. 203·6	24in. I×84½, S.M. 200·5
22×7 ×75, S.M. 152·4 ..	22in. I×73, S.M. 161·5 22in. I×67½, S.M. 148·1
20×6½×65, S.M. 122·6 ..	20in. I×62, S.M. 123·6 21in. I×60, S.M. 124·0
18×6 ×55, S.M. 93·5	18in. I×52, S.M. 94·3
15×6 ×45, S.M. 65·6 ..	16in. I×40, S.M. 65·8 15in. I×42½, S.M. 65·2

I hope Mr. Hurst can spare some of his valuable time for an analysis of these broad flange beams.

Personally, when working in Canada and U.S.A., I found them very efficient and the extensive ranges of beams available made for economy in design and fabricating costs.

I am hoping for the time to come when broad flange beams will be rolled in this country and hold the opinion that if they were available our engineers would soon appreciate their worth and use them. It is difficult to see how the limited range of British beams can compete in foreign markets against the more efficient American shapes. Might I venture to suggest that Mr. Hurst in his sphere as a member of the Steel Research Committee raises this important matter for early consideration ?

G. S. BOWERS, A.M.I. Struct. E.

Chingford, Essex, March 24th.

BRITISH LOCOMOTIVE DESIGN.

SIR,—In the article by Mr. W. A. Tuplin on "The Trend of British Express Locomotive Design"—THE ENGINEER, February 5th, 1932—giving a well-reasoned *résumé* of the development of certain fundamental features during the past thirty years, there occurs a point which, in the interests of historical accuracy, appears to call for emendation. I refer to the ninth and tenth paragraphs, where, under the heading of "Valves and Valve Gear," the Great Western Railway is given a rather exclusive credit for the adoption of piston valves in 1902, whilst other railways are stated to have made slow progress until about 1910.

Now in 1893 the late Mr. S. W. Johnson, of the Midland Railway introduced piston valves on five of his 4–4–2, 7ft. 6in. "single" engines. Then, after an interval of three years, in 1896 it was used on five further identical engines and five of similar type, but having 7ft. 9½in. driving wheels and larger boilers. With "No. 117" of this last batch was recorded during its early years the then highest authenticated speed of 90 m.p.h. From that time all the Midland express engines—except a solitary ten built in 1900 to a previous design—were constructed with piston valves. All these valves were, in Mr. Johnson's time, of the pattern derived from Mr. W. M. Smith, of the North-Eastern Railway, and whilst it is true that long valve travels were not associated therewith, yet the facts show a definite adoption of piston valves in 1896, after a trial period of three years.

There also appears to be a *non sequitur* in that portion of the article dealing with "Boiler and Fire-box," where, at the commencement of the paragraph on grate area, it is stated that a large grate may be undesirable in an engine whose exhaust pressure is low. A grate area is not proportioned to suit a given exhaust pressure ; on the contrary, for obvious reasons the exhaust pressure is kept as low as is compatible with obtaining the necessary output from the boiler. With a large grate a lesser exhaust pressure suffices than with a smaller one for the same power output and running conditions. For this reason an appreciable portion of the remainder of the paragraph in question and the succeeding one is invalidated, particularly the comparisons made between the 4–6–0 and the 4–6–2 types of locomotives.

P. C. DEWHURST, M.I. Mech. E.

Montevideo, March 5th.

PAPERS AND DISCUSSIONS.

SIR,—Thanks are due to THE ENGINEER for the very interesting leading article arising out of the reading of Messrs. Robinson and Nesbitt's paper before the Institution of Mechanical Engineers on March 18th.

I have recently been able to attend meetings of the Institution for the first time for some years, and have been struck by the falling off of the discussions.

No doubt, as you say, this may be due to the establishment of local branches ; but this does not, I think, go altogether to the root of the trouble.

Conversation with various members has made me come to the conclusion that there is a very general feeling that papers are cut down so much when read at meetings that it is almost useless to listen to them unless one has studied them before the meeting.

Discussion is too limited. The chairman appears to hold a list of people who intend to speak and calls upon them in turn. Whether these people have been invited to speak or whether they themselves have expressed the wish to do so because they believe that they have something worth saying, I cannot say, but incline to the former view.

It is obviously impossible to have a paper such as that under consideration read and discussed in the space of an hour and a-half, which is about all that is allowed. The paper itself is reduced to about twenty minutes and the subsequent speakers must either be content to say they agree with what has been said or not without going as fully as they should into their reasons, and the writer of the paper has only time to make the briefest of replies.

It would seem better to go back to the previous method, *i.e.*, read the paper in full or nearly so, and, if sufficient time was not left for a full discussion, then adjourn the meeting for another evening, when the discussion could be continued. This method had the advantage of allowing anyone both to study the paper at leisure and also to think over the best way of bringing home any point he wished to make.

R. P.

London, March 28th.

WROUGHT IRON.

SIR,—When we come to examine any industry back for a lifetime—fifty years—have the younger generation paid any attention, or as much, to their particular trade as they ought to have done ? Did they start where their fathers left off ?

When dealing with this trade—wrought iron—we have to go back for one hundred years before steam power was invented. During my time steam power has been very troublesome and expensive to drive hammers, rolls, &c. If our younger generation had started where their fathers had left off this could have been improved. We, in my time, have had to stop at work many hours longer than has been necessary because of shorter steam. This has caused a great amount of unpleasantness on both sides, what with furnaces being fired, which is a great waste of coal and iron. It is strange how this kind of thing should have been allowed as long as it has all over the country. We have had in my time forty works in Staffordshire, Lancashire, Derbyshire, and Yorkshire. These forty works could be put into four works and could be done wiser and find work for the unemployed men who are in this particular trade—wrought iron—in Staffordshire, Lancashire, Derbyshire, and Yorkshire.

Now I will deal with the question of this old-fashioned trade. When we are about to make anything for reliable purposes you must be sure to get your puddled bars made. It has not been necessary to use the great amount of coal which has been used in the past. This can be reduced. When I was in an ironworks last week it came in my mind the works could be put more like an ironworks for 1932 than in 1862, as a man could stand up to do his work, and the management would feel as if they were managing something worth passing their useful time on. Quality cannot be made under bad systems which are not healthy.

RALPH CLIFF (Shingler).

Sheffield, March 28th.

WATER DIVINING.

SIR,—Sympathy should be extended to the reviewer of Mr. Henri Mager's book on "Water Diviners and their Methods," and also to the author in his attempt to classify divining in the category of science.

The book of Nature is one which takes long to read and we should admit that the forces of Nature are not limited to the small number of those with which we are acquainted. There is a great amount of evidence that such phenomena as water divining and "apports" do happen, and I personally have had experience of both. As an engineer and sceptic, I recall my experience of holding between my thumbs and first fingers the ends of a piece of ordinary galvanised wire extending from the hands of a dowser, and seeing and feeling the wire turn from a horizontal to a vertical position against my effort to prevent it. I am inclined to think that why and how the rod moves cannot be explained in terms of physical science, and that the theory of intuitive perception is appropriate. It should be remembered that during the Great War our troops in Gallipoli, in direst need of fresh water, benefited by the diviner's art, and in 1926 the Government of India appointed Major C. A. Pogson as their official diviner, with significant results. The question whether water divining or dowsing is a physical or psychical phenomenon has not yet been answered satisfactorily by expert investigators, and now that an Association of Water Diviners has been instituted in France to study methods and results, &c., let us hope that an explanation understandable by engineers will be forthcoming.

H. E. YERBURY, M. Inst. C.E.

Maidenhead, March 21st.

OBITUARY.

E. C. CLARK.

WE regret to have to record that Mr. E. C. Clark, a director of the Broughton Copper Company, Ltd., Manchester, died on Wednesday, March 23rd, 1932, at the age of seventy-six years. He had served the company from the age of thirteen, and graduated through all the commercial and sales departments. He was manager of the Scottish office for five years, from 1890 to 1895, after which he returned to headquarters as chief assistant to the sales department under the late Mr. J. B. Mercer, and joined the board of the company in 1903. In the course of his business career he toured the world, and in recent years devoted his attention largely to British Dominion and foreign trade. He served under two chairmen, the late Mr. W. Sumner, and the present chairman, Mr. Leonard Sumner. On reaching his jubilee with the company he was presented by the directors and staff with suitable mementoes of the event. During his career he had held onerous positions directly and indirectly connected with the political side of business. He was Vice-president and a member of the Council of the Federation of British Industries, and was chairman of certain non-ferrous trade organisations, and a member of the Committee of the Manchester Guardian Society for the Protection of Trade.

BOOKS RECEIVED.

Metallurgy. By Edwin Gregory. London : Blackie and Son, 50, Old Bailey, E.C. 4. Price 17s. 6d. net.

Eureka : An Essay in Economics. By R. M. Sneddon, Glasgow : The Political Bookshop, 132, Bothwell-street. Price 2s. net.

First Principles of Television. By A. Dinsdale, M.I.R.E. London : Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 12s. 6d. net.

Zinc and its Alloys. Circular of the Bureau of Standards No. 395. Washington : Superintendent of Documents, D.C., U.S.A. Price 70 cents net.

Fuel Testing, Laboratory Methods in Fuel Technology. By G. W. Himus, B.Sc., &c. London : Leonard Hill, Ltd., 231–2, Strand, W.C. 2. Price 15s. net.

Steel and its Practical Applications. By Wm. Bass and A. J. K. Honeyman, B.Sc. London : Blackie and Son, Ltd., 50, Old Bailey, E.C. 4. Price 6s. net.

Practical Physics. Third edition. By W. R. Bower, B.Sc., &c., and J. Satterley, D.Sc., &c. London : University Tutorial Press, High-street, W.C. Price 7s. 6d. net.

Steam Power Stations : Equipment and Maintenance. By G. O. McLean. London : Crosby Lockwood and Son, Ltd., Stationers' Hall-court, E.C. 4. Price 7s. 6d. net.

The Mercantile Year Book and Directory of Exporters, 1932. By W. Lindley Jones, O.B.E. London : Lindley-Jones and Brother, Ltd., 32, Bishopsgate, E.C. 2. Price 20s. net.

Marlborough's German Technical Words and Phrases. Third edition. By E. M. Rolffs. London : E. Marlborough and Co., Ltd., 51, Old Bailey, E.C. 4. Price 7s. 6d. net.

Lärm und Resonanzschwingungen im Kraftwerksbetrieb infolge periodischer Strömungsvorgänge. By Dr.-Ing. F. Michel. Berlin : V.D.I. Verlag, Dorotheenstrasse 40, N.W., Germany. Price 7.50 marks net.

Sailing Ships : Their History and Development as Illustrated by the Collection of Ship Models in the Science Museum, Part II. By G. S. Laird Clowes. London : His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

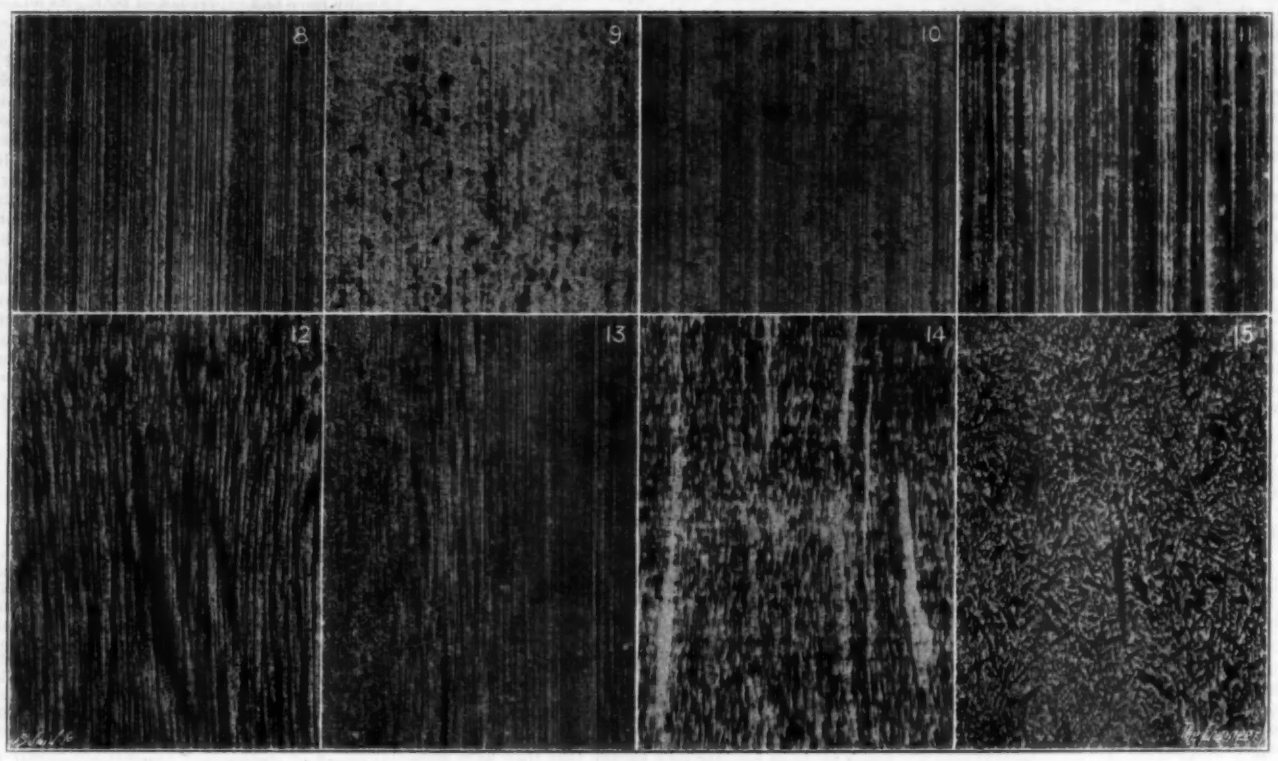
The Machinability of Steel as Indicated by its Macrostructure.*

By F. E. ROBINSON, M.I. Mech. E., and C. T. NESBITT.

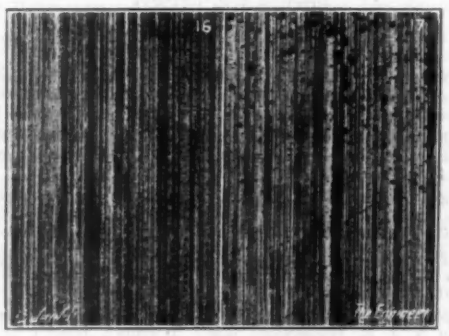
(*Concluded from page 350.*)

Examination of Tests of Barrel Steel Supplied by Various Makers.—In the experiments described above, the trials had been confined to a batch of steel supplied by one firm only and to various batches left over from war stock. Inquiries were issued to some half-dozen well-known makers of rifle-barrel steel for the supply of 5 tons of barrel steel to the Enfield Specification No. 2, Appendix II. The firms were invited to send technical representatives to discuss the quality of steel required, and the whole method of macro-examination was explained and demonstrated to them in the works laboratory. These representatives were also shown the drilling process and the results obtained in the preliminary tests.

One firm at its first attempt produced a very satisfactory delivery of steel, the macrostructure of which agreed closely with the standard already determined. Supplies from the other firms proved unsatisfactory. No firms beyond the two referred to have succeeded in producing a steel which meets Specification No. 2, Appendix II. Characteristic macrographs are shown in Figs. 8 to 15, and the



FIGS. 8 TO 15



FIGS. 16 AND 17

results of drilling tests taken at random from the various tests are given in Table I.:—

TABLE I.—*Results of Drilling Tests.*

	Number of stops of machine.	Surface of hole drilled.	Straightness of bar after drilling.
Fig. 8..	Nil	Good	Straight
„ 9..	Large number	Rough	Bent
„ 10..	2	Fair	Straight
„ 11..	Large number	Rough and dark	Bent
„ 12..	1	Rough dark	Badly bent
„ 13..	Nil	Very rough, dark	Straight
„ 14..	1	Rough dark	Badly bent
„ 15..	1	Rough dark	Bent

Experiments with steels having the characteristic structure shown in Figs. 4 and 5 have enabled drilling speeds of nearly 130ft. per minute with a feed of $\frac{1}{16}$in. per minute to be adopted as standard practice. Further experiments on drilling at speeds up to 200ft. per minute are now being carried out with very promising results.

For certain reasons it became necessary to improve the mechanical properties of the steel by raising the yield-point from 26 tons to at least 36 tons per square inch, yet leaving it machinable to the condition laid down in Specification No. 2, Appendix II. Two batches of material were selected, one showing the standard structure as illustrated by Fig. 5, and one with the structure as illustrated by Fig. 10. The machining of the latter steel, in the normalised condition, was known to be indifferent, and the object of making this particular selection was to ascertain whether the effect of heat treatment would be to improve the machining properties of the steel. To obtain the required result, bars from the two batches were heat treated by raising them to a temperature of 850 deg. Cent., quenching in oil, and then tempering at 550 deg. Cent., this treatment giving a yield-point of 38 tons per square inch and an ultimate strength of 60 tons per square inch.

The results far exceeded expectations, the bars with the standard structure being drilled without the slightest trouble at the increased rate as mentioned, whereas the bars showing the indifferent structure could not be drilled, despite the fact that the drilling rate was reduced to the original feed and speed, and the consequence was that the bars had to be discarded. Macrographs of the bars, as treated, are shown in Figs. 16 and 17, Fig. 16 being the good steel, and Fig. 17 the indifferent steel, which also shows a certain number of inclusions. As a matter of interest, a small section of steel showing the standard

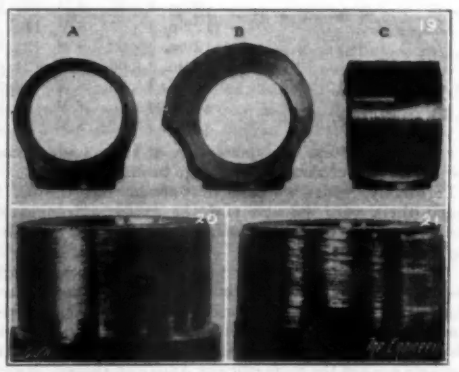
FIG. 18

structure was quenched in water from a temperature of 950 deg. Cent. Naturally, after this somewhat drastic treatment the metal fractured, but, as can be seen, the bands still persist. The macrograph of this is shown in Fig. 18.

Examination of Carbon Steels for General Machining.—The specialised operation of long-hole drilling having been investigated, it was decided to examine the problem of good and bad machining on capstan lathes and automatic screw machines. Considerable variation in quality of work and wear of tools was occurring on a component manufactured from rifle-barrel steel. A large number of bars had accumulated from the long-hole drilling experiments. It was decided to utilise them for producing the components shown in Fig. 19 (A). The machine used for production was an automatic screw machine fitted with a gang of five tools. In a short time it was found that production varied from forty to fifty components without resharpening the tools, to two or three components only before the tools became blunt. The bars which gave the bad results had to be removed from the machine as being useless from the machining standpoint.

On investigation it was found that the indifferent bars, when cut into sections and etched, gave characteristic macrostructures as illustrated in Fig. 10, whereas the higher production rate was from bars having a standard macrostructure as shown by Figs. 4 and 5 (*ante*). The effects of machining are illustrated in Figs. 20 and 21. Fig. 20 shows the surface of the material with the standard structure, while Fig. 21 shows the surface of the bars with the indifferent structure. A number of components from the indifferent material were passed from the above machine to a further machine for rotary milling, but it was quickly found that it was impossible to carry out this operation. The high-speed steel collet mill simply rode over the surface of the work, with the result shown in Fig. 19 (B and C). These results indicated that macrostructure was a reliable index of ordinary machine operations on bar materials.

The second case investigated was also in connection



FIGS. 19 TO 21

with general capstan work. In this instance the opportunity was taken to compare steels from three different contractors. The material was to Specification No. 1,† bright-rolled. Figs. 22 and 23 show the structure of two deliveries, from the same contractor, at widely different periods. These, as will be seen, show the banded structure, whereas Figs. 24 and 25, relating to supplies from separate contractors, have a totally different appearance. The specimen shown in Fig. 24, after prolonged etching, was coated in places with a very firmly adherent deposit of copper, which was difficult to remove, while that shown in Fig. 25 had a surface composed mainly of extremely fine lines.

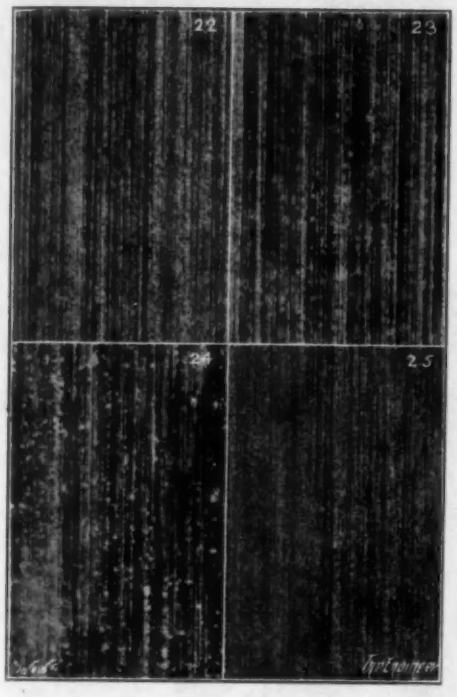
The machining properties of these steels are almost beyond comparison. Material with the banded structure could be machined extremely satisfactorily with a production rate of forty components without resharpening the tool, the gauge limits being maintained throughout. On

* The Institution of Mechanical Engineers.—March 18th.

† This Specification was given in our issue of March 25th.—Ed. The E.

the other hand, material with the structure shown in Fig. 24 lowered the production rate some 30 per cent., with corresponding reduction in life of tools and indifferent gauging, while material shown by Fig. 25 was almost useless. In a good many cases the tools produced only about five components before failing, the quality of machining was indifferent, and the gauge tolerances were difficult to maintain.

Owing to the very short life of the various tools, the services of the machine setter were almost fully engaged in looking after the small production obtained. To show the results of machining on the surface of the component, photographs are reproduced in Figs. 26 and 27. These illustrate the effect of face-turning on the two extremes of material. The material shown in Fig. 26 had the structure shown by Fig. 22 and formed the thirty-fifth component



FIGS. 22 TO 25

produced, whereas the material shown in Fig. 27 had the structure shown in Fig. 24 and formed the second component only.

The third case investigated was the production of components from a steel of much higher carbon content to Specification No. 3, Appendix II., and the material was supplied by two contractors. The machining was again carried out on an automatic screw machine. Fig. 28 (A) was photographed from material showing the structure of Fig. 29, while Fig. 28 (B) was from material with the structure shown by Fig. 30. As will be seen, the results are very different. Material illustrated by Fig. 29 could be machined crisply, with a well-sustained life of the tools, gauging very satisfactorily, and giving no production trouble whatever. On the other hand, material shown in Fig. 30 was a continual source of trouble; the production rate was extremely small, the life and wear of the tools was unsatisfactory, and the work was generally indifferent. Again, the difference in macrostructure is pointed out and it is suggested that this is an index of the machinability of all plain carbon steels.

One further case, which is practically self-explanatory, is illustrated. Figs. 32 and 34 show the effect of a face-turning operation carried out on an automatic screw machine. The material was a British Standard blue-reeled steel to Specification No. 4, Appendix II., and it produced widely different results on the machine. It was found that the material was supplied from two contractors, and it was this fact, coupled with the difference in macrostructure, which explained the difference in quality of the work produced. Fig. 31 shows the macrostructure and Fig. 32 the surface of the work as produced from bars which were in every way satisfactory, whereas Figs. 33 and 34 show the macrostructure and work produced from bars which gave very indifferent machining results, and here, as in the examples already given, production was bad and tool upkeep prohibitive.

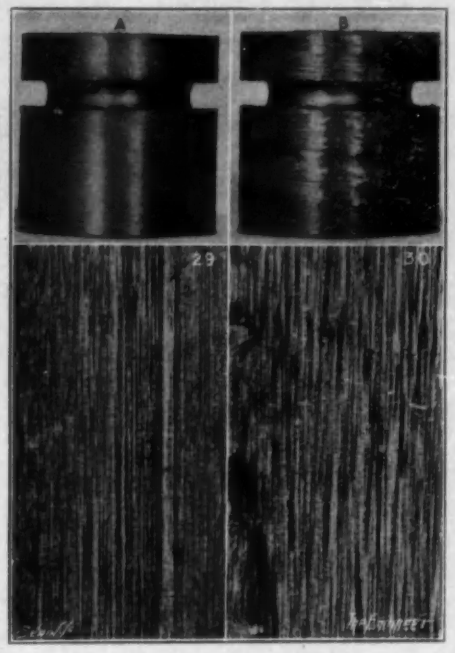
Examination of Carbon Tool Steels.—A totally different class of material is now considered, namely, tool steels. These are illustrated in Figs. 35, 36 and 37. They are as supplied from three contractors, to Specification No. 5, Appendix II., and are water-hardening steels. That represented by Fig. 35 is far superior in macrostructure to those corresponding to Figs. 36 and 37. The working qualities of this steel were in every way excellent. The steel shown in Fig. 36, on the other hand, possessed very indifferent qualities as regards machining, while Fig. 37 shows one of the most unsatisfactory tool steels examined. The etching of the steel shown in Fig. 37 was somewhat difficult. The white patch on one side of the macrograph is a deposit of copper which could not be readily removed. Several plug gauges machined from varous bars of this steel had to be discarded owing to the serious distortion after hardening.

Fig. 38 shows a macrograph of a somewhat lower grade of tool steel than those shown in Figs. 35, 36 and 37, and is to Specification No. 6, Appendix II. The whole structure points to indifferent machining qualities. This was actually the case, for in the various machining operations which the material underwent complaints that no finish could be given to the work were frequent. On comparison with Fig 35 it is clear that the complaints were justified.

Figs. 39 and 40 show a comparison of two supplies of oil-hardening gauge steel to Specification No. 7, Appendix II. The difference in macrostructure is again noticeable. The steel whose macrostructure was as shown in Fig. 39 machined satisfactorily, plugs and screwed plug gauges taking a very fine finish, and there was a minimum distortion in hardening; whereas the steel with the structure shown by Fig. 40 gave unsatisfactory results in the manufacture of screw gauges, both as regards thread finish and distortion in hardening.

Examination of Nickel Steels.—Figs. 41, 42 and 43 show a series of macrographs of nickel machine-gun barrel steels and nickel case-hardening steels to Specifications Nos. 8 and 9 in Appendix II. The difference in the macrostructure is apparent. The difference in machining qualities was again very pronounced, and especially in drilling operations. Material corresponding to Fig. 41 was extremely good, whereas that illustrated in Fig. 42 was decidedly inferior. Fig. 43 shows a macrograph steel to Specification No. 9. It may be mentioned that the structure shown in Fig. 43 was most difficult to develop, and was in itself an index of the material's inferior machinability.

Examination of Nickel-chrome Steels.—It has only been possible to make a preliminary examination of nickel-chrome steels, but so far the results tend to agree with the tests of the steels already dealt with. Fig. 44 is a macrograph of a piece of nickel-chrome steel bar to Specification No. 10, Appendix II. Fig. 45 is from another size of bar. The steel shown by Fig. 45 gave the best finish on being machined.



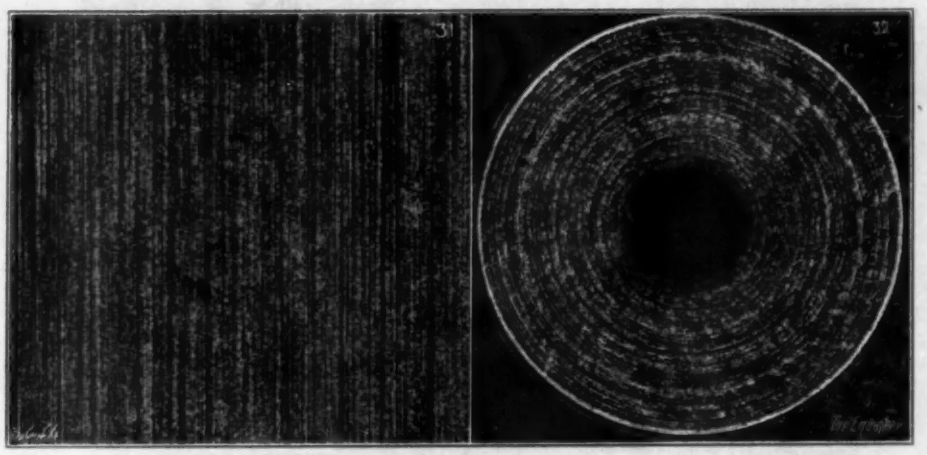
FIGS. 28 TO 30

Stainless Steels.—Mechanical engineers are generally familiar with the difficulties of machining stainless steel. Certain deliveries of stainless steel of 0·3 per cent. carbon and 12 to 14 per cent. chromium content were giving very different machining results on screw machines in one of the Royal Ordnance Factories workshops. Four samples were supplied from four contractors respectively, but no indication was given as to who the contractors were, or what was the order of merit of the four steels as regards machinability. It was not known what would be the effect of Rosenhain's reagent on the highly polished sections; but within a very short time a definite structure appeared on all four steels. The order of machinability, as indicated by the macrostructure, was picked out independently by several observers. The order of merit, as indicated by the works laboratory tests, agreed with the relative ease of machinability of the supply from the four contractors.

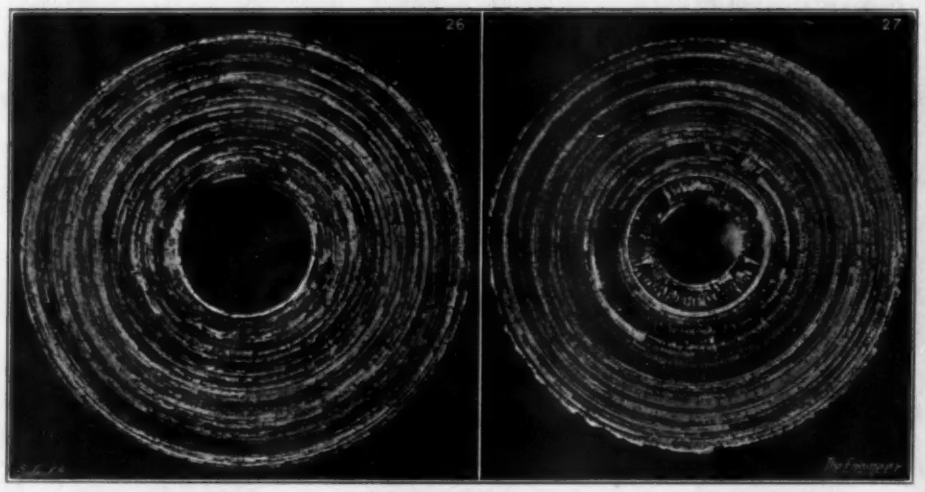
In order to secure satisfactory macrographs, etching and repolishing had to be repeated several times. The macrostructure of these stainless steels in order of merit is shown by Figs. 46, 47, 48 and 49.

Microscopical Examination.—A number of specimens of good, bad, and indifferent steel have been examined microscopically after etching with 2 per cent. nitric acid in alcohol. This etching medium brings up faint lines on visual examination. They are not nearly so distinct as the lines brought up with a copper etching reagent, such as Rosenhain's, and appear to be useless for detecting machining qualities. Under the microscope, in almost all the numerous specimens examined, ghost lines, i.e., distinct, lightly etched bands, are present. These bands are not due to segregated ferrite entirely, though in some instances a small proportion of segregated ferrite is present. They appear to be due to some dissolved constituent in the steel resisting the action of the acid. It is possible that oxygen may play some part in this banding effect. Professor F. C. Thompson‡ recently indicated that oxygen was most probably the cause of segregated ferrite bands in steels of low carbon content. It is possible that the same cause produces the lines in the 0·5 per cent. carbon steels under examination, as experiments have failed to indicate phosphorus as being the cause of segregation.

In an endeavour to correlate bad machining or drilling qualities with microstructure there has been no success.



FIGS. 31 AND 32



FIGS. 26 AND 27

‡ Paper read before the Iron and Steel Institute, September, 1931.

Grain size appears to have little or no influence. Examination of the drawn-out hair-like non-metallic inclusions present to a greater or less degree in all the steels examined shows them to be manganese sulphide in most cases where the inclusion is sufficiently wide to demonstrate its nature.

At one time during the investigation it was thought that slag or oxide associated with the manganese sulphide was only present in the bad machining samples. This has not been substantiated by further work; non-metallic inclusions occur in various forms, and similar conditions exist in steels of good and bad machining properties, and, except in the very bad samples, more or less to the same extent.

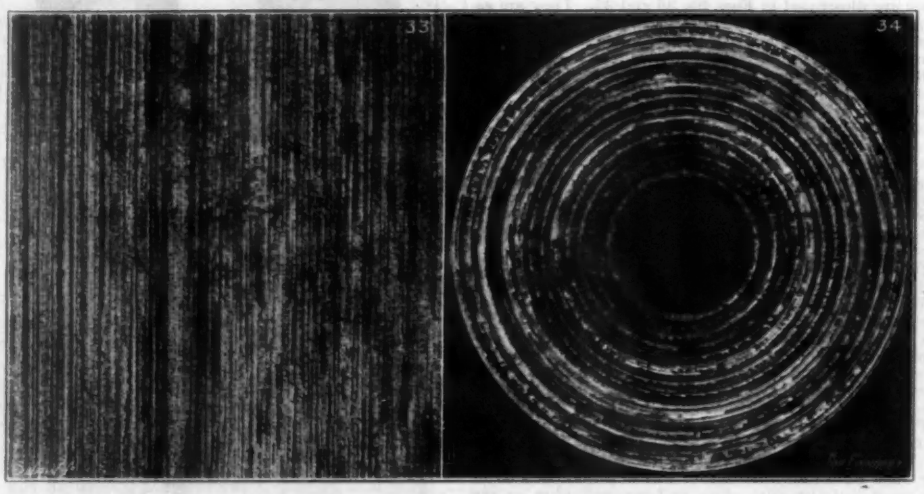
Figs. 50 and 51 are photomicrographs of rifle-barrel steel of good machining properties to Specification No. 2, Appendix II. Figs. 52 and 53 are photomicrographs of steel of indifferent machining properties, and Figs. 54 and 55 are photomicrographs of steel of bad machining properties. These photomicrographs were taken at an original magnification of 100 diameters.

This concludes the investigations. It will be noted that throughout the recorded results on general machining operations no mention has been made respecting cutting speed and feed of the various tools. This was considered unnecessary, as all the operations on each component were carried out immediately following each other in ordinary tool-room and machine-shop production processes, and are directly and absolutely comparable.

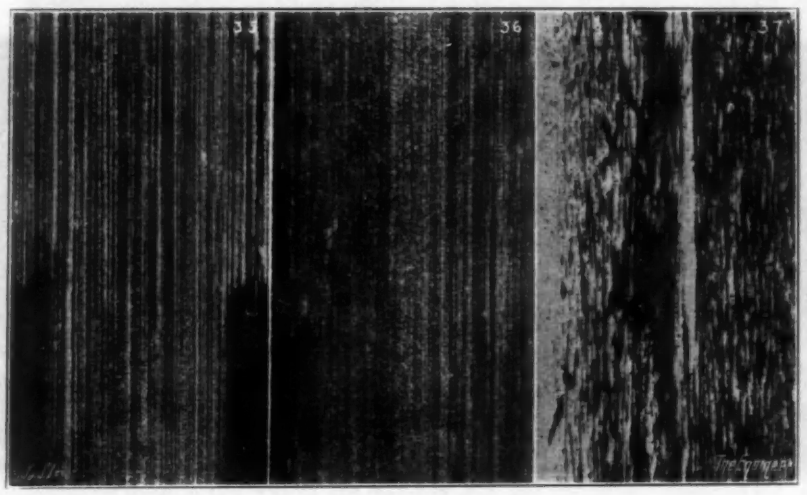
Conclusions.—It is believed that macrostructure is a definite index of the machinability of steel. The line of research which has been followed introduces possibilities of investigation into problems of machining certain alloy steels which have hitherto caused much difficulty to engineers engaged on machining components made from these steels.

No theory has been advanced regarding the method whereby the best macrostructure of steel for machining purposes can be obtained, but all the evidence that has been collected tends to indicate that the formation of the most suitable structure arises in the casting of the ingot and its treatment prior to rolling into billet form. It is suggested that this is a problem which demands much closer attention from the steel maker and metallurgist than has hitherto been the case. The wide range of macrographs which illustrate this paper show clear evidence of wide variation in the way in which the casting of the ingots has occurred and the way in which the ingots have been manipulated before they were rolled into bar form.

The authors desire to express their thanks to the Army Council and to Sir Reginald Townsend, K.C.B., Director of Factories, War Office, for permission to use the photographs and the information in this paper, and to the Controller of H.M. Stationery Office for permission to reproduce the photographs and extracts from official specifications; to Mr. H. Woodhouse, Metallurgist to the Royal Small Arms Factory, and to the staff at the Royal Small Arms Factory, Enfield, and at the Royal Ordnance Factories, Woolwich, for their valuable assistance in preparing the data and illustrations for this paper. They are also indebted to several well-known steel manufacturers in Sheffield for the assistance they have rendered and the interest they have shown in their investigations and experiments.



FIGS. 33 AND 34



FIGS. 35 TO 37

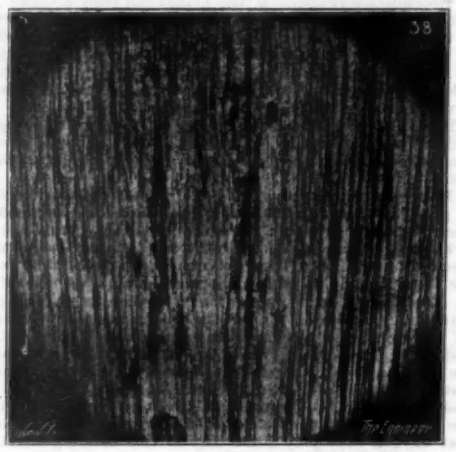
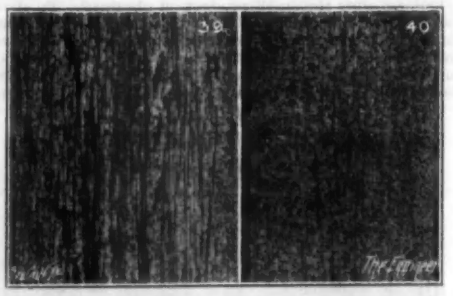


FIG. 38



FIGS. 39 AND 40

APPENDIX II. (*continued*).

No. 2. Excerpt from Specification S. 105, Based on S.W.E. S/30, Governing the Supply of Steel for Rifle Barrels.

The steel shall contain

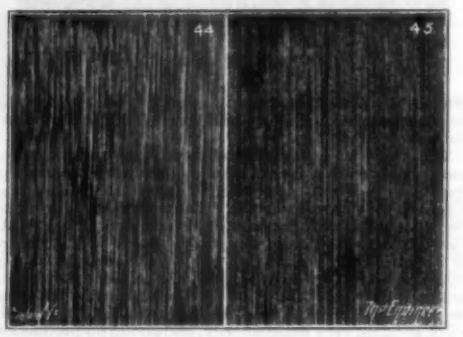
	Per cent.
Carbon	From 0·5–0·6
Silicon	Not above 0·25
Manganese	From 0·5–0·7
Phosphorus	Not above 0·03
Sulphur	„ „ 0·03

All steel shall be manufactured in accordance with the best current practice, and shall be so controlled in the casting and subsequent processes as to give the peculiar properties characteristic of long drilling or deep-hole drilling steel.

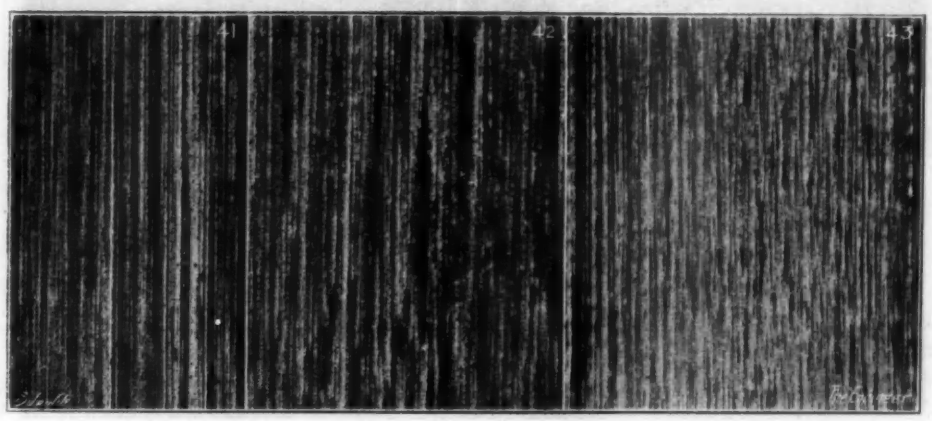
A sufficient discard shall be made from each ingot to secure freedom from pipe and undue segregation, and other defects.

All bars shall be sound, commercially straight, and free from piping, surface defects and hard or soft spots.

The ends of the bars to be sawn at right angles and to be free from burrs.



FIGS. 44 AND 45



FIGS. 41 TO 43

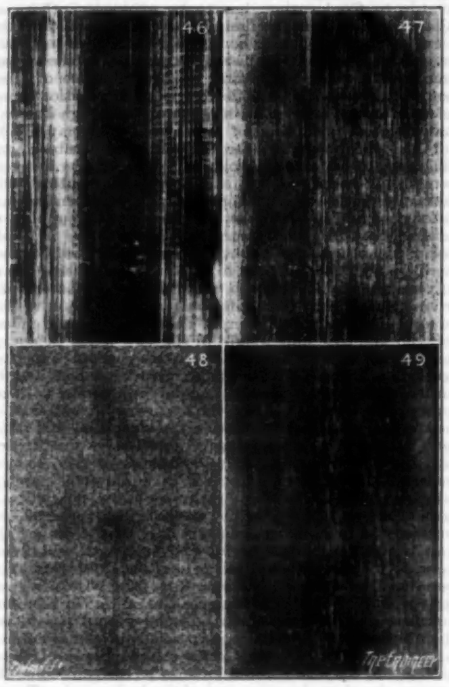
The bars to be supplied normalised—that is, they shall be heated to a temperature exceeding the upper critical point, held there for approximately fifteen minutes, and allowed to cool freely in air.

British Engineering Standards Association test pieces—0·564in. diameter by 2in. gauge length—will be cut from

the bars as received and must give the following mechanical test :—

Yield-point	Not less than	26 tons per sq. in.
Ultimate stress	„ „	45 „ „
Extension	„ „	20 per cent.
Contraction of area	„ „	35 „ „

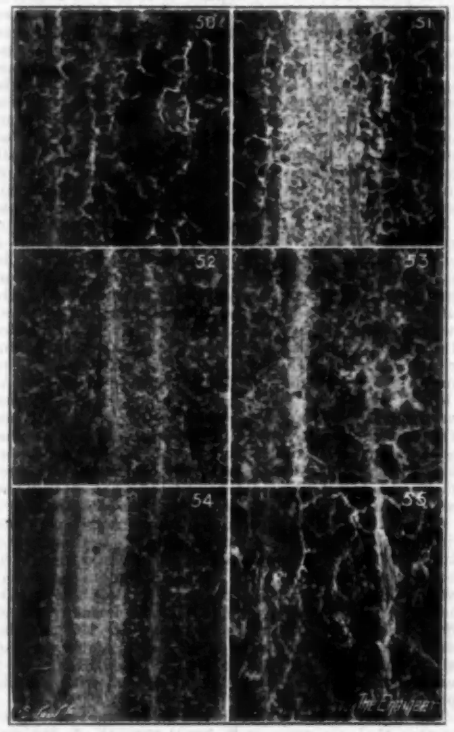
Bars selected at random from the bulk supply by an Officer of the War Department will have test pieces



FIGS. 46 TO 49

approximately 26in. long cut from them and drilled in a rifle-barrel drilling machine, or, alternatively, rifle barrels will be forged at the Royal Small Arms Factory from selected bars and drilled as above at a cutting speed of approximately 90ft. per minute, or, alternatively, the drill will be fed through the test bar or barrel at a feed of not less than $\frac{1}{16}$in. per minute.

The drill must penetrate the test bar or barrel from



FIGS. 50 TO 55

end to end without resharpening, and the hole must be of uniform diameter, clean, bright, smooth and straight.

No. 3. Excerpt from Specification S.W.E. S/78.

Analysis, per cent.		Mechanical test, tons per sq. in.	
Carbon	0·90–1·20	Ultimate stress	50 (as rolled)
Silicon	0·220 max.	Ultimate stress	38 (annealed)
Manganese	0·15–0·45		
Phosphorus	0·02 max.		
Sulphur	0·02 max.		

No. 4. Excerpt from Specification S.W.E. S/48.

Analysis, per cent.		Mechanical test, tons per sq. in.	
Carbon	0·5–0·6	Yield-point	19 minimum
Silicon	0·1–0·3	Ultimate stress	35 „
Manganese	0·45–0·60	Extension	15 per cent. min.
Sulphur	0·04 max.	Contraction of area	20 per cent. min.
Phosphorus	0·04 max.	The fracture should be fibrous	

No. 5. Excerpt from Specification O.F. No. T.R./1.

Grade A : Temper No. 1.

Carbon	1·0–1·2 per cent.
Manganese	0·45 per cent. max.
Phosphorus	0·025 „ „
Sulphur	0·03 „ „

No. 6. Excerpt from Specification O.F. No. T.R./1.

Grade B : Temper No. 3.

Carbon	0·8–0·9 per cent.
Manganese	0·55 per cent. max.
Phosphorus	0·045 „ „
Sulphur	0·045 „ „

No. 7. Excerpt from Specification O.F. No. T.P./1 to Govern the Supply of Non-shrinking Oil-hardening Steel for Tools and Gauges.

(1) The steel is to be of the non-shrinking oil-hardening variety, suitable for the production of high-class tools and gauges.

(2) The chemical composition of the steel is left to the contractor, who must supply a complete analysis of the steel when tendering.

(3) The steel must be capable of being hardened in oil at a reasonably low temperature in order to avoid scaling, and after hardening must have a Brinell hardness of approximately 600.

(4) When the steel is hardened in oil, its change in dimensions for unit volume must be consistent and small.

(5) The steel shall be reasonably easy to harden and temper, shall be free from injurious defects and must be supplied in the normalised condition, *i.e.*, reheated after final working to a temperature above the hardening temperature and allowed to cool in air.

(6) Tools made from the steel, when hardened and tempered in accordance with the maker's instructions, shall give in service a high standard of efficiency.

No. 8. Excerpt from British Engineering Standards Association Specification No. 5005/401.

Chemical analysis, per cent.		Mechanical test, tons per sq. in.	
Carbon	0·25–0·35	Yield-point	32 minimum
Silicon	0·30 max.	Ultimate stress	45 „
Manganese	0·35–0·75 max.	Elongation	22 per cent. min.
Phosphorus	0·05 max.	Reduction of area	50 per cent. min.
Sulphur	0·05 max.	Brinell hardness No.	192 minimum
Nickel	2·75–3·50		
Chromium	0·30 max.		

No. 9. Excerpt from British Engineering Standards Association Specification No. 5005/103.

Chemical analysis, per cent.		Mechanical test, tons per sq. in.	
Carbon	0·15 max.	Ultimate stress	42 minimum
Silicon	0·30 max.	Elongation	18 per cent. min.
Manganese	0·20–0·60 max.	Reduction	45 „ „
Phosphorus	0·05 max.		
Sulphur	0·05 max.		
Nickel	2·50–3·50		
Chromium	0·30 max.		

No. 10. Excerpt from British Engineering Standards Association Specification No. 5005/501.

Chemical analysis, per cent.		Mechanical test, tons per sq. in.	
Carbon	0·28–0·34	Yield-point	45 minimum
Silicon	0·30 max.	Ultimate stress	55–65
Manganese	0·45–0·70	Elongation	18 per cent. min.
Sulphur	0·05 max.	Reduction of area	50 „ „
Phosphorus	0·05 max.	Brinell hardness Nos.	241 to 311
Nickel	3·00–3·75		
Chromium	0·50–1·00		

SIXTY YEARS AGO.

THE spectre of invasion disturbed the slumbers of our fathers sixty years ago. They had seen in France and in Austria what invasion meant, and while they recognised that our frontier was the sea, they were far from feeling secure that the Navy could prevent the landing of a foreign army on our shores. According to the popular view, such an army, if it ever came, would land either near Brighton, Hastings, Dover or Harwich. It was also commonly held that at the first threat of invasion all our available military forces would be concentrated in London ready for transport by rail to the point of attack. In our issue of April 5th, 1872, we suggested that neither as regarded the probable landing-places nor as concerned the steps which would be taken to check the invaders would popular opinion prove to be right. Nevertheless, wherever the enemy landed, and whatever might be the disposition of our troops, the railways would certainly be called upon to move the Army, its stores, guns and horses, and to concentrate them rapidly against the invaders. Were our railways in a fit state to undertake the task ? We had some considerable amount of doubt on the subject. There was an absence of any peace-time preparation for the task, and we did not feel assured that in a sudden emergency our railway managements would operate smoothly and without confusion. It was doubtful whether either the railway companies or the military authorities knew precisely what calls would be made upon them, and what equipment was available for the transport and handling of our troops and our warlike material. It was possible, we thought, that so far as the entraining and movement of the men were concerned the railways would be able to meet the situation fairly satisfactorily, but as regarded the handling of the stores, fodder, ammunition, guns, and horses—especially the horses—it was probable that the railways, for lack of previous preparation, would operate with delay and confusion. We, however, took some consolation from the facts published in a recently issued pamphlet concerning the railways of Germany and the manner in which they fulfilled the tasks thrown upon them by the campaigns of 1866 and 1870. The pamphlet, the work of an Austrian, revealed a state of chaotic muddle on the German railways, produced not by the emergency of war, but by the defects of their peace-time organisation. In all respects, the author found the management and equipment of British railways superior to those of German railways. Yet the German had rendered great service in the recent wars. Perhaps, should the emergency arise, the British would give a better account of themselves than would be expected. The time of trial came in August, 1914. It was, may be, less severe than would have been the movements involved in the repulsion of an invasion, but the history of those early days of the Great War, when the British Expeditionary Force was being sent to France, will always reflect brightly on the efficiency and adaptability of our railways and all connected with their operation.

Fuel for Merchant Ships.*

By J. JOHNSON.

(*Concluded from page* 249.)

THE slower type of cargo vessel—Class C—is next considered. Here again, in considering new tonnage, the most modern and commercially attractive type of oil engine must be taken as the standard by which to judge the improved steamer. Nowadays there are relatively few trades which are not served by regular lines, so that the quantity of tonnage in this category is, in future, likely to be smaller for this as well as other reasons already given. To employ capital profitably by trading with this class of vessel against competition from any and every quarter is a formidable task, and, as is well known in shipping circles, calls for most expert management and unceasing alertness in grasping every opportunity, large or small, of earning freights. It is important, therefore, at the outset, to settle what is likely to be the most effective trading unit for this class of business. On the assumption that an average return of 5 to 10 per cent. is to be secured on the capital invested, the question arises as to whether a cheap vessel somewhat high in operating costs, or a relatively costly one of lower operating costs, is likely to prove more suitable. What might be called the "factor of employment" is of considerable weight here, for compared with a cargo liner operating on a fixed schedule, the employment of the lower-grade slow-speed vessel is irregular, and likely to be marred by spells of inactivity or unprofitable work. When she is not employed, depreciation and certain other expenses have, nevertheless, to be allowed for. When employed, depreciation and insurance, as a percentage of the cost of the vessel, have to be defrayed before earnings rank for payment of return on capital. The class of cargo carried by these ships is generally rough, freights are comparatively low, and general experience indicates that the most satisfactory basis upon which to engage in the trade is the smallest capital cost compatible with a fairly good propulsive efficiency. Technical improvements, even of a minor order, have to be closely scrutinised to ascertain whether they are likely to prove a sufficiently attractive investment, and similar remarks apply to cargo-handling equipment, which is idle for the greater part of the vessel's life, and is often rendered unnecessary by the use of wharf machinery and port equipment, as in the case of grain cargoes. Owners of this type of ship attach great importance to propelling equipment of severe simplicity which must be robust enough to stand a good deal of casual treatment. While in the past choice of machinery has been circumscribed by *personnel*, a better class of engineer and rating is now available. The designer can also contribute by incorporating features which limit the influence of the attendants upon the economical working of the plant, restricting their functions to the watching of lubricating and other services, executing adjustments and minor repairs. In order to illustrate the case a ship of 11 knots sea speed, having about 2000 S.H.P., has been selected.

The two-stroke double-acting Diesel installation of this power would weigh 470 tons ; fuel consumption per S.H.P.-hour for all purposes, 0·39 lb.; consumption of lubricating oil, 14 gallons per day ; revolutions, say, 80 per minute ; piston speed, 750ft. per minute.

In new steam tonnage of this class consideration will necessarily be given to the claims of oil now becoming more competitive with coal, apart from its use in Diesel engines. Something may be said for the use of a L.P. turbine in conjunction with a reciprocating engine, for it reduces the steam rate per horse-power by 25 per cent. with a corresponding contraction in the size of the boiler, certain auxiliaries and bunker capacity. It is questionable, however, in ships of this class whether it is worth the cost and complication it entails, for it represents a deviation from the simple standards which are generally insisted upon. For 2000 S.H.P. or less a turbine drive is less attractive and would entail the use of double-reduction gearing. At such small powers the advantage of water-tube boilers over Scotch is less marked, and if an auxiliary boiler is installed for port purposes the general features of the installation begin to decline from the standard best suited to the case. It is proposed, therefore, in respect of such ships, to limit the comparison to the Diesel engine and steam reciprocating machinery with Scotch boilers.

The slow-running marine steam engine of triple or quadruple type has developed from primitive beginnings, but if it is to be retained it should be designed to run at much higher piston speeds in totally enclosed form under forced lubrication, with poppet valves substituted for the piston and slide valves. When one considers the piston speeds, weights of moving parts and the temperatures and pressures to which pistons and piston-rod glands of Diesel engines are subjected, a clean working fluid, such as steam, might well be utilised at an initial temperature of 700 deg. Fah. or higher. If cylinder lubrication by oil is employed there is, of course, the difficulty of purifying the feed water, which practically precludes the use of this type of engine with high-pressure water-tube boilers. A separator placed in the exhaust pipe may be depended upon to remove the greater part of the oil from the steam, thereby avoiding fouling of the condenser. A modern steam installation of the reciprocating type would therefore consist of a quadruple-expansion engine, working with steam of 250 lb. pressure, 700 deg. Fah. initial temperature, vacuum 27in., running at 80 revolutions per minute, and have small-diameter cylinders, long stroke, and a piston speed of

* Read at the Institution of Naval Architects, March 17th, 1932.

about 900ft. per minute, and, under these conditions, a mechanical efficiency of 92 per cent. might be expected. The major auxiliaries would also be driven by enclosed forced lubrication engines, using superheated steam. A convenient boiler arrangement would be two small units, each sufficient for two-thirds of the designed power, either of them being available for port use. They would be arranged to burn pulverised coal or oil at an efficiency of 90 per cent. It is singular how opinion fluctuates regarding the efficiencies obtainable with water-tube and Scotch boilers, for, given proper combustion, the reclamation of heat in the two cases need not be sensibly different. The difference in radiation losses could be eliminated by air jacketing the Scotch boilers.

The fuel consumption of an installation of this size, working under the prescribed thermal conditions and with a boiler efficiency and mechanical efficiency of 90 and 92 per cent. respectively, would not exceed 1·0 lb. coal or 0·68 lb. boiler oil per S.H.P.-hour. Gross weight of installation 425 tons. The corresponding daily fuel costs are illustrated in Table V., the lowest ruling prices being taken, as in the case of the larger and faster vessels.

Table V.

	Fuel per S.H.P./hour all purposes, lb.	Fuel per day, tons.	Fuel cost per day, at sea.
			£ s. d.
Motor ship, 2000 S.H.P.—			
Diesel oil at 30s. per ton ..	0·39	8·35	12 10 0
Excess lubricating oil ..	—	—	1 0 0
			£13 10 0
Steamship, 2000 S.H.P.—			
Coal at 15s. per ton ..	1·00	21·40	£16 1 0

As both vessels would on the score of first cost have steam deck and auxiliary machinery, it will be necessary to consider the gross annual fuel costs in both cases. For this purpose 240 steaming days and 120 days in port have been assumed. The motor vessel would consume 5·75 tons of oil per day in port, whereas the steamer would take 8 tons of coal or 5·75 tons of oil.

It should be observed that with this class of steam machinery boiler oil does not become competitive with coal until it falls to 22s. per ton, and for this reason the comparison has, in the first instance, been confined to coal. Furnace oil is, however, being sold to-day in some ports at less than this figure, and when so procurable the steamer would bunker accordingly. The costs corresponding to a price of 16s. per ton are therefore shown in Table VI. for

Table VI.

	Fuel consumption per annum. At sea, tons.	In port, tons.	Total, tons.	Annual costs. Fuel.	Lubricating oil.	Total.
Motor ship, 2000 S.H.P.	2005 (30s.)	690 (16s.)	2695	£3559	£600	£4159
Steamship, 2000 S.H.P. (coal)	5136 (15s.)	960 (15s.)	6096	4572	350	4922
Half coal at 15s.	2568	480	3048	3958	350	4308
Half oil at 16s.	1745	345	2090			
All oil at 16s.	3490	690	4180	3344	350	3694

guidance. In the design of steamer—Class C—mentioned above, permanent bunker capacity of 860 tons of coal is provided, sufficient for about forty days' steaming, or, say, 10,000 miles. Reserve capacity for an additional 900 tons is situated convenient to the boiler-room, and it is interesting to note that she can carry this extra weight on an additional expenditure of 1 ton of coal per day. Both these compartments would be available for cargo when oil fuel was in use.

Table VII. shows how the two vessels compare in respect of weight and volume of cargo carried.

Table VII.

Machinery (including seatings).	Fresh water.	Fuel for 40 days, plus allowance for port purposes.	Total weight: machinery, water, bunkers.	Cargo deadweight.	Cargo space.	Remarks.
Motor ship—2000 S.H.P.—						
470 tons ..	50 tons	384 tons (oil)	904 tons	Datum	Datum	Condition of vessels leaving U.K. coal port
Steamship—2000 S.H.P.—						
425 tons ..	100 tons	900 tons (coal)	1425 tons	Minus 521 tons	—	
Motor ship—2000 S.H.P.—						
470 tons ..	50 tons	720 tons (Oil for 80 days)	1240 tons	Datum	Datum	Condition of vessels leaving cheap oil port
Steamship—2000 S.H.P.—						
425 tons ..	100 tons	634 tons (Oil for 40 days)	1159 tons	—	Plus 16,000 cubic feet	

As frequent mention has been made of the location of cheap coal and oil zones, these are shown for convenient reference in a map accompanying the paper, while Table VIII. shows the cheapest prices of coal and oil at ports

Table VIII.

	Price per ton. Coal.	Boiler oil.	Diesel oil.	
	s.	s.	s.	
United Kingdom ..	15	—	—	
	—	24	30	Persian Gulf
South Africa ..	18	—	—	
	—	20	36	Panama Canal zone
Australia	18	—	—	
	—	40	45	East Indies
Japan	20	—	—	
	—	24	30	U.S. western seaboard
U.S. eastern seaboard	16	16	37	U.S. eastern seaboard

situated at or near to these areas. They are in each case what might be described as natural bunkering ports, comparatively little expense having been incurred in transporting fuel to the point of shipment. Where these are off ordinary trading routes the larger and faster type of ship would not deviate, but smaller and slower vessels might find it profitable to do so.

For purposes of illustration the approximate cost of these vessels, 8000 tons deadweight, to an average specification, may be taken as :—

Motor ship, £82,000, including £37,000 total machinery cost.

Steamship, £75,000, including £30,000 total machinery cost.

The motor ship cost in this case includes engines of British manufacture, for, in this size of plant, United Kingdom prices are practically competitive with Continental ones. It is interesting to observe that in this class of vessel depreciation at 4 per cent. and insurance at 2½ per cent. comprise a heavier disbursement than the total annual fuel bill. They must be defrayed and interest on capital earned at some time or another, and, consequently, any special equipment provided to promote fuel economy must conform to the same rule, and save annually not less than, say, 15 per cent. of its first cost. The motor ship in this case must therefore bear an additional annual charge of £1050. The motor ship does not exhibit any tangible superiority in fuel expenses over the steamer using coal and oil alternately, and the small margin shown is contingent upon her getting Diesel oil at the lowest price quoted. There is, in fact, little to choose between the fuel bills of the two ships, so that, allowing for the irregular nature of their employment, there is no doubt that the cheaper vessel, having the option of burning coal or furnace oil, is the more attractive proposition. This type of cargo ship frequently leaves this country with a small quantity of freight to trade either between foreign ports or to bring back special cargoes, for which the steamer, having consumed her coal, possesses a greater available hold capacity, and in certain cases steamships would find it profitable to leave the United Kingdom with both their permanent and reserve bunkers filled with coal. The earlier type of steamship, having triple-expansion engines, hand-fired Scotch boilers and a moderate degree of superheat, would cost £70,000, including £25,000 for machinery complete, but her annual fuel costs would be roughly £2000 higher than those of the modern steamship, and the number of ratings somewhat greater. After defraying extra investment and other charges on the modern steamer there would be a net saving of not less than £1000 per annum, and it appears, therefore, that the earlier type of steam propelling plant must give way to something of a more efficient order along the lines now indicated.

In considering the case for the retention of coal the frankest recognition of its physical limitations is necessary. Whereas oil can be bought with assurance that its calorific value and other characteristics will conform closely to specification, and that the quantity contracted for will be delivered and readily checked, coal upon occasion can be exceedingly troublesome. Variations in physical characteristics, excessive wetness, presence of foreign matter, deviation in sizing and short weight not infrequently cause annoyance and disappointment, and as sampling and checking of large consignments is at best a rough-and-ready process, vexatious disputes with suppliers occur over adjustments in cost. Much progress, however, has been made in recent years, and matters are gradually being put on a more satisfactory footing. Coal should be more carefully prepared for the marine market, and suppliers must give careful consideration to this if it is to be less of an annoyance than it now occasionally is. To lift coal to the same level of utility as oil for marine purposes is a heavy task, although by no means an impossible one, for when one considers the high standards prevailing in power stations and the economical results already obtained by mechanical stoking at sea, there is every justification for believing that with active co-operation between all parties coal need not be sensibly inferior to oil as a marine fuel for ships of the classes under review.

There are over one hundred plants in this country using powdered coal, and many on the Continent and in the United States. Results are good, indifferent, and sometimes bad. It has to be admitted that there is room for improvement; but, on the other hand, great progress has been made with the pulveriser, the burner, and the design of furnace, and, given sufficient inducement, the art will develop towards perfection. In power stations, mechanical stokers have recently made much progress at the expense of powdered coal, and the point immediately arises as to whether they are not more suitable for steamships. In view of the fact that 4 per cent. of the fuel consumed is expended in pulverising, whereas only ½ per cent. is absorbed in working the stoker mechanism, the former process needs further justification. When both systems use suitable fuel and are worked at peak efficiency, powdered coal will show 1 per cent. advantage, due to the fact that it can operate steadily on 15 per cent. excess air, whereas the stoker requires 40 per cent. on average working. In selecting coals for stokers too high a ratio of volatile to fixed carbon has to be avoided; otherwise, falling off in efficiency will ensue. Furthermore, difficulty is experienced in burning completely coals with too low a volatile, and output may be reduced or unburned coal pass over with the ash. Allowing for the influence of these factors, there would be little to choose in practice at sea between the net efficiencies of the two. Although it is true that any and every kind of bituminous coal may not be suitable for pulverising, the range is considerable; and while, as in the case of stokers, it is desirable to avoid using coals having a low ash fusing temperature, this characteristic is of less importance when furnaces are water cooled. In any case there are ample supplies of suitable coal in this country and elsewhere. Whereas stoker repairs average about 2d. per ton of coal burned, there are no grate renewals to be considered in the case of pulverising equipment, and repairs to the beaters and driving mechanism with soft coals are small, and of this there is now ample testimony. There is nothing to choose between the cost and weight of the two kinds of equipment, but the stoker occupies a valuable part of the furnace envelope. Given suitable design, powdered coal can be burned with great rapidity, and in conjunction with an appropriate furnace enables the size, weight, and cost of the steam-generating installation to be reduced to a minimum, a condition most necessary for effective competition with the Diesel engine. Powdered coal, in fact, secures practically the same advantages as liquid fuel, namely, reduction of lighting up and stand-by losses, flexibility of output, and so forth. Facility in changing over to oil is of considerable importance. In the case of the stoker the grate would have to be carefully covered with well-fitting firebrick to prevent air leakage; considerable radiation losses would have to be accepted, as otherwise the grate parts would reach a high temperature, and it is therefore improbable that the maximum efficiency would be attained when burning oil. As there is no space for the accommodation of oil burners in way of the coal hoppers and stoker mechanism, the latter would have to be dismantled or the burners placed at the other end of the boiler and sufficient space allowed for their operation, which would add to the dimensions of the stokehold. It would also be necessary to provide additional air passages and control dampers for the alternative modes of firing. Whereas highly preheated air up to, say, 500 deg. Fah., is beneficial with powdered fuel, it introduces an element of risk with the stoker, and necessitates the use of expensive grate parts. Clearly, the ideal arrangement for marine work is one which permits of a change over from coal to oil with the minimum of disturbance and the obtaining of peak efficiency, whether burning coal or oil. The question of mechanical stokers *versus* powdered coal only applies, of course, to vessels in Class B, as the stoker is not applicable to Scotch boilers. A point of prime importance is the price to be paid for coal in the two cases. In this connection it has to be remembered that the mechanical stoker shows to greatest advantage when burning a mixture of nuts and smalls. The desirability, therefore, of purchasing these sizes with due regard also for limitations in maximum and minimum volatile hardens prices. On the other hand, there are fair grounds for concluding that the vessel able to use smalls and dust in powdered form and able also to change over with facility and minimum expense to oil would obtain supplies of coal on the most advantageous terms possible.

Much interest is now being evinced in the possibility of extracting oil from coal on a commercial scale. It is generally known that petrol, Diesel and furnace oil can be made from coal by hydrogenation or low-temperature distillation; but, unfortunately, the cost is high. The author understands that spirit, for all practical purposes the equivalent of petrol, can be prepared and distributed at the same price as is petrol to-day, but as the selling price of the latter includes 8d. per gallon tax, the use of the home-made commodity at the same price would involve a loss to the State. The cost of Diesel or furnace oils prepared in this way would be prohibitive for marine purposes. Whatever the future may hold, it appears, therefore, that the most attractive application of coal to meet present-day engineering standards will be in the raw state, powdered in a compartment which can be isolated when oil is in use, and the stokehold thereby kept in a clean condition.

An examination of this problem would not be complete without reference to future developments. In the hands of skilful designers, reductions in dimensions and weight will doubtless be made in both Diesel and steam machinery without any sacrifice of robustness or durability. The thermal and mechanical efficiency of the former does not offer much scope for improvement, but in the latter further advances may be anticipated in the way of higher pressure and temperature, say, 600 lb. and 900 deg. Fah., and a boiler efficiency of 95 per cent., associated with the disappearance of funnels.

The object of this paper is to exhibit the relationship between the economics of fuel and the art of ship propulsion in its present state, and it but remains now to apply the conclusions to be derived from this study. Fuel must be available before a system of mechanical propulsion can be employed at all, and supplies procurable at a suitable price, if vessels are to be operated profitably, and the importance of this must in no wise be underestimated. It is submitted, therefore, that the choice of fuel ranks first in importance, the type of propelling agent being subordinate thereto. In commercial practice these elements are combined in the cost of fuel and cost of propelling machinery, and provided the latter is reliable and cheap enough, the dominant consideration is therefore choice of fuel. If the cost of fuel, which is compounded of quantity and price, is substantially equal in two competing systems of propulsion, the shipowner will naturally select that type which affords him the greatest immunity from a rise in fuel costs or disturbance of service. Modern steam machinery which satisfies these searching tests has already reached a stage of development which warrants its general adoption, and its efficiency is susceptible of further improvement. Based upon the use of home fuel and the

option of taking cheap fuel oil or coal at foreign ports, it will augment the competitive power of British shipowners. While shipbuilders will continue to build what their clients specify, they may, when called upon to prescribe, find it not incompatible with their interests to advocate the use of propelling machinery able to utilise coal, as an improved system of propulsion incorporating optional use of fuel may be confidently expected to encourage and accelerate the replacement of old tonnage. During the past two decades the annual consumption of British bunker coal has fallen from thirty to twenty million tons, and if present tendencies continue unchecked it will be relegated to a position of insignificance, if not eliminated entirely from the marine market. This must be a matter of grave concern to those directly identified with the coal industry. They may be obliged eventually to choose between offering suitable coal at prices competitive with oil or suffer the gradual extinction of this section of their market, but it appears to be within their capacity to retain a substantial share of the bunker trade.

A nation which has secured a major part of the world's carrying trade and controls the requisite fuel supplies for the operation of its tonnage has a definite economic advantage. Modern steam propulsion of attractive initial cost, combining, as it does, lightness and efficiency, with choice of fuel, will prove a valuable factor in maintaining the strength of this dual position. Its merits will be generally realised and appreciated only as concrete examples become available, and action, therefore, on the part of those concerned is urgent and necessary if shipowners and others are to have suitable guidance before replacement programmes are undertaken.

APPENDIX.

Exchange Rates.—Fuel prices throughout the paper are given in sterling, and in the case of the United States—coal and oil—the conversion rate of 4·86 dollars to the £1 has been employed. Under present-day conditions the sterling equivalent of these coal and oil prices would be higher, but both would be affected to the same extent; in other cases "gold standard" rates of exchange have been used. Similar remarks apply to the prices of Continental machinery. These matters are rather outside the scope of the paper, and any points which arise in connection with exchange would have to be considered on their merits.

Size of Machinery Spaces.—In designing machinery spaces of cargo vessels the present practice is to endeavour to make them not appreciably more, but in no case less than 13 per cent. of the gross tonnage of the vessel in order that the deduction of 32 per cent. allowed under the present tonnage laws may be obtained in computing the net registered tonnage. Developments in propelling machinery, whether internal combustion or steam, are making possible a contraction in the size of these spaces without any sacrifice of safety, accessibility, or comfort. Under the present regulations, if these machinery spaces are less than 13 per cent., an allowance of only one and three-quarter times their actual tonnage is made, so that, as matters stand, a disability is incurred by the shipowner if smaller machinery spaces are adopted. It would appear that having regard to engineering developments, present and prospective, some revision of these tonnage allowances may become necessary if their incidence is to be equitable, and to secure this the limit of 13 per cent. might be lowered to, say, 10 per cent. or less. The amount paid by way of port dues and pilotage, &c., varies considerably according to locality, but in ships such as have been used for illustration in the text of the paper the gross figure charged per annum for the larger vessel might amount to £7000. Although there are clauses in the tonnage regulations intimating that individual cases will be considered on their merits, the literal application of the rules would involve an annual excess impost of roughly £1100 on a steamer of this type with small machinery spaces. A consideration to be kept in view is that when ships arrive at certain United Kingdom ports, with their double-bottom tanks partly filled with fuel oil, the capacity actually occupied is added to the tonnage and dues made chargeable thereon.

The Iron and Steel Institute.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 5th and 6th, 1932, commencing each day at 10 a.m.

PROGRAMME OF PROCEEDINGS.

Thursday, May 5th.—10 a.m., general meeting of members. Presentation of annual report and statement of accounts for 1931; election of new members; presentation of the Bessemer Gold Medal to Professor Henry Louis, M.A., D.Sc.; presentation of the following papers for discussion:—W. R. Brown, "Blast-furnace Engineering;" J. Tornblad, "Recent Improvements in the Greenawalt Sintering Apparatus;" A. Fry, "The Theory and Practice of Nitrogen Case Hardening;" J. E. Hurst, "Some Experiments on the Nitrogen Hardening of Cast Iron." 2.30 p.m., afternoon session. Presentation of the following papers for discussion:—Sir H. C. H. Carpenter, F.R.S., and J. M. Robertson, "The Austenite-Pearlite Inversion;" L. W. Schuster, "The Influence of the More Common Elements in Inhibiting Needles in Nitrogen-rich Steels and Arc Welds;" A. J. Bradley and A. H. Jay, "The Lattice Spacings of Iron-Aluminium Alloys." 7.30 p.m., annual dinner of the Institute in the Grand Hall, Connaught Rooms, Great Queen-street, W.C.

Friday, May 6th.—10 a.m., general meeting of members. Announcement of the award of the Andrew Carnegie Research Scholarships for 1932–33; announcement of the award of the Williams Prize to Mr. Arthur Robinson, Scunthorpe; presentation of the following papers for discussion:—"Fourth Report on the Heterogeneity of Steel Ingots," by a Joint Committee of the Iron and Steel Institute and the National Federation of Iron and Steel Manufacturers; A. Kriz, "The Heterogeneity of a Sand-cast Steel Ingot;" E. Maurer and W. Bischof, "Behaviour of Manganese in the Acid Open-hearth Process." 2.30 p.m., afternoon session. Presentation of the following papers for discussion:—G. D. Bengough and A. R. Lee, "The Action of Sea Water on Mild Steel;" D. J. Macnaughtan, S. G. Clarke, and J. C. Prytherch, "The Determination of the Porosity of Tin Coatings on Steel;" G. Burns, "The Properties of some Silico-manganese Steels."

AUTUMN MEETING.

The autumn meeting of the Institute will be held in London on Tuesday, Wednesday, and Thursday, September 13th, 14th, and 15th, 1932. It will take place concurrently with that of the Institute of Metals, and the sessions will be held by kind permission at the Institution of Civil Engineers, Great George-street, Westminster.

INTERNATIONAL FOUNDRY CONGRESS, PARIS.

An International Foundry Congress (Congrès Mondial de Fonderie) will be held at Paris on September 13th to 17th, 1932, and the President and the Committee of Organisation have issued an invitation to the members of the Iron and Steel Institute to participate therein. The proceedings will open with a reception on the evening of Tuesday, September 13th, and sessions for the discussion of papers and reports will be held at the Sorbonne on the mornings of September 14th, 15th, 16th, 17th. In the afternoons excursions will be made to places of technical interest, and the evenings will be devoted to social functions. A Foundry Exhibition organised by the Syndicat Général des Fondeurs de France will also be held during the week of the Congress.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Easter Vacation.

INDUSTRIAL activity in the Midlands and Staffordshire has been very much below normal this week. While some of the steel works and engineering establishments closed down for only two or three days at Easter, at others and at some of the manufacturing works the vacation extended over the whole week. In the iron rolling mills in Staffordshire the duration of the stoppage is indefinite, for unless there is a sufficient accumulation of orders during this week it will not be possible to resume operations on Monday. Ironmasters are, however, hoping to be in a position to limit the stoppage to a week. The quietness of business on the iron and steel market has naturally been accentuated by the Easter holiday, and transactions this week have been very few. Few buyers or sellers have been in attendance on 'Change until to-day—Thursday—when there was a fairly good crowd on the floor. While some small tonnage orders were given out and deliveries ordered against existing contracts, little was done in the way of second quarter business. Manufacturers hereabouts appear to be much behind under contracts given to iron and steel masters at the opening of the year, their requirements not having come up to anticipations. Their consumptive needs are in many cases covered over the next month or six weeks, and under present conditions they hesitate to make further commitments. Even where supplies in hand relate to a briefer period, there is little inclination to enter into fresh negotiations. Supplies of iron and steel are in advance of requirements and there is no need for thought as to the execution of orders at short notice. Moreover, where selling prices are not subject to control they show a decided tendency to fall, and users are of opinion that, generally speaking, there is more likelihood of prices falling than of their rising, and they are naturally anxious to buy forward only on the best possible terms. The spring quarterly gathering of industrialists in Birmingham is now being looked forward to, as it is believed it will reveal a brighter outlook than did its predecessor. It is thought, too, that manufacturers will be in a position better to estimate their probable requirements of material for the next three months.

Midland Operations.

Improvement has come to some Staffordshire and Midland industries, included among which are the automobile engineering trade and its allied manufactures. At some of the works full time is being made and at others night shifts are in operation. The Easter break was short for motor engineers, most of whom resumed work on Tuesday or Wednesday at the latest. Though production at some of the factories for the present season is below that of a year ago, there has been a decided rush of business during the past few weeks. Output of cars, alike private and commercial, has been speeded up, while makers of components have had to hurry along production. Overseas orders for commercial vehicles have also increased in volume recently. While most branches of engineering in Staffordshire remain rather slack, there is a general tendency towards improvement. Constructional engineers, perhaps, are the least actively employed at date. Midland foundrymen are reasonably active, firms producing light castings finding a moderately good call for their output. Iron and steel masters are not doing at all well, demand continuing poor in all branches. Electrical engineering throughout the area remains active and there are signs of a betterment of the position in the hardware, hollow-ware, and lock trades of the Black Country. The future for these trades is not, however, assured.

Electrical Progress.

During the year 1931 the consumers of electricity in the area supplied by the Shropshire, Worcestershire, and Staffordshire Electric Power Company increased by about 34 per cent. Although a considerable loss of demand was experienced because of the restriction of power loads as a result of industrial depression, the units sold for the year were only slightly less than those sold in the previous year. Since the close of the company's financial year conditions have improved, and there are, the company state, indications of a steady expansion and satisfactory return of the power load. During the year no less than forty-eight new districts have had supplies of electricity made available to them for the first time. The accounts of the company for the year show a balance of £274,091 13s. 11d. available for appropriation.

A Substantial Profit.

The report of Baldwins, Ltd., the Midland iron and steel and colliery masters, for 1931 shows that, despite adverse conditions, a successful year's trading has been carried out. The profit for the year was £174,080, and though trading conditions were considerably worse than in the previous year, the works of the parent and subsidiary companies—with the exception of the Landore Steel Works—and the collieries were all employed throughout the year. The British—Guest, Keen, Baldwins—Iron and Steel Company, Ltd., showed a manufacturing profit of £174,077, as against a considerable loss last year.

Pig Iron.

The restriction of activities at the foundries this week has resulted in a worsening of the position of blast-furnacemen, who have been compelled to put a large part of their production into stock. The outlook for Midland blast-furnacemen does not appear to be very bright, for although there is some slight improvement in the light castings industry, it has some way to go before it reaches the stage of consumption prevailing at the beginning of the year. General engineers and forgemen are calling for very little material. This week's orders from these sources have been negligible. Selling prices of pig iron are due for revision by the Central Pig Iron Producers' Association, but this week quotations have been on the recent fixed basis. Derbyshire No. 3 foundry is quoted £3 6s., forge £3 1s., Northamptonshire foundry £3 2s. 6d., forge £2 17s. 6d., North Staffordshire foundry £3 6s., forge £3 1s., all per ton delivered Black Country stations.

Steel.

Work at the steel mills in this district is on a day-to-day basis, and there has been little material produced this week. Some small orders are on makers' books, but the difficulty of securing specifications, particularly from Midland constructional engineers, has been intensified by the Easter holidays. Foreign agents continue to compete keenly for business in this market and their quotations, whether for finished material or for semis, are below those of local steel masters. Not much business is, however, to be had. The recent reduction of half-a-crown per ton in the selling price of Staffordshire re-rolled bars has brought an equivalent reduction in Continental quotations, which this week are down to as low as £4 12s. 6d. Controlled steel selling prices are upheld at the Association fixed figures. Uncontrolled prices are as follows:—Boiler plates, £8 10s.; small bars, re-rolled from foreign billets, £6 7s. 6d. upwards; all-British bars, £7 5s. upwards; mild steel billets, £5 5s. to £5 7s. 6d.; sheet bars, £5 upwards; Staffordshire hoops, £9 10s.

Finished Iron.

There is no change to record in the Staffordshire wrought iron industry on the week. There has been hardly any activity at the works, and ironmasters are hoping for some accumulation of orders on which they can make a restart next week. Up to the middle of the week, however, few orders had been added to the books and the outlook was stated to be decidedly poor. Practically all the orders now on hand, whether for high-grade bars or for common iron bars, are for small tonnages. Values are unchanged. Marked bars are £12 per ton at makers' works; Crown bars, £9 5s. upwards; nut and bolt bars, £8 7s. 6d.; and wrought iron tube strip, £10 10s. upwards.

Galvanised Sheets.

Prices of galvanised corrugated sheets are upheld on the basis of £9 10s. for 24-gauge corrugateds. Many mills are endeavouring to obtain better terms, but they do not appear to be meeting with much success.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Boiler Inspection.

IN spite of the general industrial depression during the past year, the annual report of the Manchester Steam Users' Association shows an increase over any of the three preceding years in the number of boiler examinations carried out by the Chief Engineer and inspectors of the Association. During 1931, 24,784 examinations were reported upon, this figure comparing with 22,283 in the previous year, 21,468 in 1929, and 24,501 in 1928, last year's total comprising 14,541 external examinations, and 10,243 internal, flue and entire examinations. In addition, a large number of steam pipe ranges were periodically inspected and reported upon. Mr. J. T. Browne, of Manchester Collieries, Ltd., who has acted as vice-president of the Association since 1922, has been appointed president in succession to Mr. Harold Lee. Mr. Lee has found it necessary to relinquish the presidency after occupying the position for the last fifteen years. Altogether, Mr. Lee has been a member of the executive committee for thirty-five years. Mr. J. S. Addison, of Courtaulds, Ltd., has been appointed vice-president. Mr. Philip Carline succeeds Mr. James Parr as secretary. Mr. Parr's period of service with the Association, including the last eleven years as secretary, extending over fifty-one years.

The Stripping of Boilers.

Reference is made in the report to the modifications of the Home Office requirements relating to the strip-

ping of boilers. It is pointed out that the new requirements, which are now effective, are much less onerous than those that were at first proposed, and the claim is made that the concessions that have been obtained are largely due to the representations made to the Home Office by the Manchester Steam Users' Association. Mr. Browne, who presided at the annual meeting, referred to the effect on the position of the Association of the gradual growth of the use of other forms of motive power in place of steam. In addition to the disuse of boilers which was going on all over the country, they had, he said, to face increased competition and the fact that other forms of motive power were gradually taking the place of steam. Proposals to improve the position, always having regard to the limits imposed upon them by the unique character of the Association's constitution, were receiving the careful consideration of the Executive Committee.

More Motor Omnibuses.

The Manchester Corporation Transport Committee has decided to seek the authority of the City Council for the purchase of thirty more motor omnibuses. The Committee approved of a proposal of Mr. R. Stuart Pilcher, the general manager of the Transport Department, that the tramway service between Ashton and Haughton Green should be converted to a motor omnibus service.

Non-ferrous Metals.

New low price levels since the departure from the gold standard have been touched in all sections of the non-ferrous metals market during the past week. At one time tin developed a somewhat bullish tendency on a belief that increased restriction of output would shortly be put into operation, and, in spite of seasonal influences, a moderate volume of buying interest, which included sales to industrial consumers of the metal in this country, was reported. Latterly, however, prices took a sharp turn for the worse, the advance in the value of the pound in terms of the leading foreign gold currencies being an important factor in this respect. Compared with a week ago, tin quotations are lower on balance to the extent of between £7 and £8 per ton. The copper market has continued dull and depressed, and a fall of almost £1 per ton in standard brands of the metal has further reflected, to some extent, the prevailing uncertainty as to the future outlook. The demand for lead during the past week has, for the most part, been limited to early requirements, and the heavy available supplies of the metal have exerted their influence on prices, these being about 10s. per ton lower than they were a week ago. Similar unsatisfactory conditions have ruled in the spelter market, and a fall on balance of rather more than £1 per ton has brought quotations to extremely low levels.

Iron and Steel.

The iron and steel markets have reopened after the holidays on a very quiet note in almost every section. Deliveries of pig iron against existing contracts have pretty well been resumed on the scale obtaining just before the break, but up to the present there has been little sign of forward buying of foundry iron attaining more important dimensions. The price position, however, is much the same as before For delivery to users in the Manchester zone, Derbyshire, Staffordshire, and Cleveland brands of No. 3 iron are quoted on the basis of 67s. per ton, with Northamptonshire foundry at 65s. 6d., Derbyshire forge iron at 62s., Scottish No. 3 at about 87s., and West Coast hematite iron at 81s. Finished iron prices are also maintained, Lancashire best quality bars being quoted at £10 5s. per ton, Crown bars at £9 15s., and the nut, bolt and fencing grade at as low as £7 per ton. Inquiry for all descriptions, however, is on an unsatisfactory scale. Few important constructional jobs are coming out in this part of the country, and almost without exception structural engineering firms locally are badly in need of work. Lancashire locomotive builders and boilermakers are also very unsatisfactorily placed, and altogether the volume of business being placed on this market with steel rollers is at an extremely low level. During recent weeks constructional engineers have been handling a somewhat bigger volume of inquiry, but otherwise there is little indication of brighter prospects in the near future. Small re-rolled bars are quoted at about £7 per ton; large bars, 3in. and upwards, at £9 7s. 6d.; boiler plates at about £8 12s. 6d., for both acid and basic sorts; ship and tank plates at £8 17s. 6d.; sections at £8 7s. 6d., and joists at £8 15s. Except that Continental iron and steel products continue to be offered at prices which are steadily dwindling, partly under the influence of the dearer pound, there is little to report in this section of the market, current bookings, which amount to only a limited tonnage in the aggregate, relating to small-sized orders in most cases.

BARROW-IN-FURNESS.

Hematite.

The holidays have naturally interfered with the general trade, but, apart from this, there is very little business doing. The orders which are being booked are not heavy, and as a result the stocks still remain relatively high. Home buyers are restricting their buying to immediate requirements, which are thin. There is a certain amount of buying of better classes of iron, but here, again, the needs of customers are slight. The output in the district is very low, as low, in fact, as ever it has been, excepting periods of enforced stoppage through causes other than bad trade. American and Continental business remains as flat as ever, and this may be taken as a sign that other countries are experiencing as bad, if not worse, conditions of trade. Iron ore, both native and foreign, is experiencing a very quiet time, and is likely to do so as long as the present number of furnaces are in blast. The steel trade continues to be very quiet. Some contracts are held, but as the time for delivery is not immediate some of them have not been started yet.

Shipbuilding.

On Thursday next, April 7th, there will be launched by Lady Eyres Monsell, the two destroyers, "Defender" and "Diamond" from the naval construction works of Vickers-Armstrong. It seems of late to have become the fashion at these works to have double launches. The first double launch was some time ago, when two Chilean submarines were put in the water the same day, and there have been several of a similar character since.

SHEFFIELD.

(From our own Correspondent.)

Poor Trade in Heavy Steel.

OWING to the Easter holidays, the heavy steel works have not been open for more than half of this week, and they have been but poorly employed, even during that period. The departments producing heavy crude steel suspended operations with poor order books and falling inquiries. Production and prices of open-hearth steel have remained about stationary for a considerable period. The United Steel Companies still have six furnaces in commission at Templeborough and two at Rotherham, and output is being maintained at a fair level at Parkgate. The position in Lincolnshire shows progress, though it is still much below its good level of about a couple of years ago. Generally speaking, there is difficulty in finding a market for the output of the furnaces. In heavy steel castings and forgings business is very flat, and there is a great shortage of work in all kinds of railway steel.

Some Good Departments.

The trade in stainless, acid-resisting, and heat-resisting steels keeps up well, and provides a large volume of employment. These materials are in wide demand for a great and increasing variety of uses. The call for automobile parts is on a considerable scale, and is keeping the drop stamps busy, while alloy steel for gears and other parts of motors that are subjected to severe wear is also wanted in good quantities. The trade in cold-rolled strip has shown improvement lately, largely in consequence of the difference in exchange rates, and shows a continued tendency to expand. There is also an increasing sale for hot-rolled strip. The Midlands and Sheffield produce the bulk of this material, and Sheffield is doing a considerable share of the trade. Several classes of Sheffield tools are benefiting through this country going off the gold standard. There is an improved trade in machine knives. Orders for farm and garden tools, however, as well as for implement parts, are disappointing, and prospects for the season are not promising. The file trade, which has passed through lean times during the last year or two, is on the up grade. Most of the firms engaged in it are able to report steady increases of sales since the opening of the new year, and the volume of business in the industry exceeds that of any part of last year. The cost of American files has gone up to such an extent that imports have practically ceased, and the stocks in this country are now nearly liquidated.

Disappointing Results.

For the second year in succession the well-known firm of Hadfields, Ltd., is paying no ordinary dividend, and it is also leaving its preference dividend in arrear since December, 1930. The directors, in their annual report, state that "the world-wide depression became more intense than ever during 1931, and this company, like most others engaged in the production of iron and steel, has been unable to obtain sufficient work to keep the plant occupied on a remunerative basis. In these circumstances the results of trading during the year have only been reached by rigorous economy in all items of expenses." They close, however, on a more cheerful note, stating that "with the return of confidence throughout the country there is now reason to believe that the general conditions affecting our industry are steadily improving." It is recommended that the sum of £25,996, standing to the credit of the profit and loss account, be carried forward. While referring to Hadfields, I may add that it is reported that they are now engaged on a valuable Russian contract for 900 large dredger buckets made of manganese steel.

Other Company Reports.

It has previously been announced that Vickers, Ltd., are paying an ordinary dividend of 5 per cent., as compared with 8 per cent. in recent years. The annual report, issued a few days ago, shows that the net profits for 1931, after deducting income tax, debenture interest, and other expenses, were £574,493, as compared with £775,926 in 1930. The reduction in the dividend amounts to £100,000, and there is no transfer to reserve, which received £100,000 in the previous year. The carry forward is £234,329, against £231,970 brought in. Edgar Allen and Co., another prominent Sheffield company, announce that, after careful consideration of the results of the year's trading and the general uncertainty of trade conditions, they are deferring the payment of their preference dividend, which is now twelve months in arrear. Their last ordinary dividend was 2½ per cent. less tax for 1929–30.

Railway Material.

My reports during the past year on the continued scarcity of work in the departments producing railway material received confirmation at the annual meeting of John Baker and Bessemer, Ltd., of Rotherham, who are primarily engaged in this trade. The company is unable to pay any ordinary dividend this year and only half a year's preference. The chairman stated that British railways had gone in for strict economy in expenditure on rolling stock, with the result that the company had had very little work from them. The trouble in India practically stopped trade with that country. South American railways had been experiencing bad times, and the state of things in Australia was well known; in fact, the company had orders on its books to-day on which deliveries were suspended. He added that, whatever form of tariff was adopted, and however the fall in the value of the pound might help them temporarily, if the present standard of living was to be maintained they must be able to sell abroad at competitive prices. That could only be maintained in a reconstructed industry, in which efficiency would be the deciding factor, together with high output; and further economies were essential in national and municipal expenditure before taxation could be reduced to a reasonable level to assist industry.

Melting by Electricity.

A new high-frequency crucible steel furnace, which is to be installed at the works of Thos. Firth and John Brown, Ltd., Sheffield, will be the largest in the country. It will have a capacity for melting a ton of steel at one heat. Most of the furnaces of this type at present in use have capacities of 600 lb. to 700 lb.

From Penistone to Sheffield.

Operations have been begun on the dismantling of the Siemens department—new works—of the English Steel Corporation, Ltd., at the Yorkshire Steel and Ironworks, Penistone. The works were closed two years ago, and the plant is to be rebuilt at the company's works at Grimesthorpe, Sheffield.

Torpedo Carriers for Spain.

Vickers (Aviation), Ltd., have despatched a Vickers "Vildebeest" torpedo carrier, fitted with a water-cooled engine, on a delivery flight from Brooklands to the Toblada aerodrome at Seville. The machine is being supplied to the order of the Spanish Government, as part of a contract for twenty-six of the same type, which will be built under licence in the factory of Construcciones Aeronauticas S.A., at Cadiz. This particular type of machine was chosen by the Spanish Ministry of Marine after an extended series of competitive trials. For the flight now started the route is Paris, Biarritz, and Madrid, where a demonstration of the capabilities of the aircraft was to be given. For this flight the "Vildebeest" is fitted with the usual landing wheels, but it can be quickly converted to a twin float seaplane, and the floats for this purpose have been despatched to Spain separately.

Collieries to be Closed.

The Tibshelf No. 1 and 2 collieries of the Babbington Coal Company are to be closed, and about 500 men and boys have received notice. The thick seams have been worked for many years, and the boundaries have been reached, and the company finds it uneconomic to work the thin seams.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Industrial Outlook.

TRADE development in the North of England is still a very slow process. There are, however, symptoms of better conditions in the near future, and the outlook is decidedly brighter than for some time past. Further improvement is noticeable in the general situation of the iron and steel trades. Purchasing of foreign iron and semi-steel for consumption in this district has now shrunk to very small proportions, although some consumers have still large deliveries to take under contracts made at the beginning of the year. Home and overseas inquiries are expanding on an encouraging scale, but in nearly all branches of the industry orders are urgently needed, and substantial increase of demand must take place before manufacturers can feel justified in preparing to restart portions of plant now laid idle through lack of work. Only seventeen of the eighty-eight blast-furnaces in this area are in operation, but the restricted output of pig iron is still adequate to requirements. In the steel trade, however, two or three additional furnaces have recently been put into commission again. Work at the shipyards and engineering works continues very slack, and, unfortunately, there is little promise at the moment of any influx of new orders. The output on the North-East Coast so far this year has been very disappointing, but all the firms are making strenuous efforts to secure orders, and very low prices are being quoted.

Cleveland Iron Trade.

Business continues to improve in the Cleveland pig iron trade. A few sales to cover summer requirements are reported this week, but consumers generally are disinclined to commit themselves extensively ahead. Stocks have increased during the holidays, but it is expected that they will again be drawn upon when the foundries and steel works resume full operations. Cleveland ironmasters continue to offer their products to Scottish consumers on substantially lower terms than to elsewhere in the hope of successfully competing for the Scottish trade with sellers of other iron. Most of the overseas business is for small tonnages, but inquiries are more numerous. For home and export, No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Rather better accounts are given of the East Coast hematite pig iron trade. Merchants have greatly lightened their holdings, and makers, though still handicapped by large stocks, are inclined to take a rather firmer stand. The latter complain that orders are still unobtainable except at figures much below cost of production. Further sales to consumers in the Midlands and in Sheffield are looked for, but buyers in those districts are very cautious. Mixed numbers are quoted at 63s. 6d. for prompt delivery, but prices are on a firmer basis for forward contracts.

Ironmaking Materials.

The position as regards foreign ore does not admit of transactions of moment, and sellers recognising

the futility of attempting to put business through have withdrawn from the market. Good medium blast-furnace coke is freely offered at 16s., delivered at the works, but consumers still have on hand large quantities of their own make.

Manufactured Iron and Steel.

The manufactured iron and steel trade is without any new features of moment. All the works resumed operations on Wednesday after the holidays. Producers of constructional steel have contracts arranged to keep them busy over the next two or three months, but other sections of the industry are rather urgently in need of orders. Prices are unchanged.

The Coal Trade.

Although the Northern coal trade has been under holiday influences this week, more business has been put through than is usual for this period of the year. Another encouraging feature is the number of inquiries circulating from Continental sources. The Genoa Municipal Gasworks has invited merchants to tender for the supply of 30,000 tons of best quality gas coal. Shipment is spread over five cargoes during April and May. Merchants have also been asked to tender immediately to the East Coast Railways of Sweden for 16,000 tons of best Northumberland or Durham coal, shipment to be in three cargoes in August, September and October respectively. The outlook is certainly a little brighter than it was before the holidays. Both Northumberland and Durham steam coals are well placed for the early part of April. Current production is thus likely to be maintained and readily cleared. Prices for early shipment are firm, and for all April are indicated at a steady level. Best Northumberland large steams are well booked for a fortnight ahead at 13s. 6d., and for later loadings quoted firmly by direct producers at 13s. 9d., and through contractors, according to shipment dates, at 13s. 6d. to 13s. 9d. Wear prime steams are in moderate supply and firm for early loading at 15s. Tyne prime large steams are holding steady at 13s., and small at 9s. There is little movement in the Durham gas coal trade, output being kept down to actual requirements. Best qualities are in good supply at 14s. 6d., and while prime Wear grades for early shipment are scarce, they are offered freely forward at 15s. Secondary gas coal is a dull trade at 13s. 6d. The best bunker coal trade is firm in tone, the demand for some weeks ahead being substantial, and prices are quoted firmly at 13s. 9d. to 14s. For ordinary bunker qualities the demand is slow and the undertone easy with ample supplies at 13s. to 13s. 3d. Durham coking unscreened are abundant at 13s. to 13s. 9d., and coking small fairly plentiful at 12s. 6d. to 13s. 3d. The coke trade outlook is very dull. Gas coke stocks are increasing, and buyers hold off. Prices are weakly maintained at 18s. 6d. for best qualities. Patent oven coke is in slow demand and easy at 15s. 3d. to 16s., there being ample stocks of good brands at the lower figure. Superior foundry coke is unchanged at 18s. to 20s.

SCOTLAND.

(From our own Correspondent.)

Steel and Iron.

THERE is no indication of improvement in the Scottish steel and iron trades. As a rule makers experience even greater difficulty in securing fresh business and plants generally are working at a rate considerably short of capacity. In the steel market the demand for heavy material is especially quiet, owing in a large measure to the scarcity of shipbuilding requirements at home and poor demands on export account. Lighter materials have fair commitments at home and abroad. Though sheet makers are better off than any other department, they are quieter than they were a few weeks ago. Lighter gauges are still comparatively well specified, but heavy sheets are somewhat neglected. Business in tubes is almost suspended pending a definite announcement on the Cartel arrangements which expire at the end of this month. Bar iron is very dull and re-rolled steel bars are in poor demand, despite a fair amount of price cutting. Prices for re-rolled steel bars are nominally unchanged at £6 5s. home and £6 2s. 6d. per ton export.

Pig Iron.

The output from the six blast-furnaces in operation at present is more than equal to all demands, owing in a measure to continued competition from Indian and English material. Prices are unchanged.

Scrap.

The market for scrap has fallen flat and prices have an easier tendency, although nominally unchanged at 37s. 6d. for heavy steel and from 50s. to 52s. 6d. per ton for cast iron machinery.

Coal.

The coal market was affected to some extent by the Easter holidays restricting the inquiry from abroad. Home demands have slackened off still further owing to mild weather conditions, and the depression in industrial circles. Supplies of most classes of round fuel are ample and prices can be arranged for a good prompt order. Prime Lanarkshire splint is a notable exception. Washed materials are irregular, double nuts being weak in all districts.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

CONDITIONS in the steam coal trade have not yet settled down owing to the holidays and continue to be distinctly on the quiet side. Shipments last week were on a reduced scale, as might have been expected, seeing that there was no work at the docks on Good Friday, while it is probable that they will be even less for the current week, inasmuch as there was no coal tipping on Monday or Tuesday and only two short shifts on Wednesday. The fact that the miners had holidays on the first three days of the week does not affect the position materially, as most collieries had more than sufficient coals standing to meet all requirements. In any event there was not such an overwhelming supply of tonnage in dock as to create undue loading pressure, as last week finished up with a total of thirty-three vacant loading berths and arrivals of steamers over the vacation have not been at all heavy. A few fresh orders have come along for fairly prompt cargoes, but they are not on such a scale as to have any perceptible effect either upon the coal or the freight market. As regards contract operations the Bristol Corporation has placed contracts for about 77,000 tons of smalls and duff for its electricity works, to be delivered over the next six months. An interesting inquiry is that from a North European railway for 8000 tons of locomotive coal, but the proviso is made that the successful firm tendering for the order must arrange for the purchase of timber equivalent to the value of the coal. Business on a reciprocal basis has previously been carried through, as Finland is taking North Country and Welsh coal in exchange for orders for pit props, which, of course, are used in the collieries, but coal for timber is another proposition, as it would mean that the coalowner or exporter securing the coal order would have to find a buyer for the wood. Reference was made last week to the fact that the order for 75,000 tons of steam coals for the Brazilian Central Railways had been secured by Germany and that it had been obtained by the Germans taking supplies of coffee in return. Since then various denials have been forthcoming that anything in the nature of an exchange of coal for coffee entered into the question. It is perfectly true that the Germans did undercut South Wales in price. Their quotation is reported to be 3d. per ton less, but so far as local firms are concerned what was of considerable importance to them was the question of payment, particularly in view of the amounts which are still owing by Brazilian consumers. The telegraphic message which came from Rio de Janeiro certainly stated that an order for 75,000 tons of coal from the Ruhr had been placed by the National Coffee Council of Brazil, and then proceeded to add that there was no question of exchanging coal against coffee, but in view of the fact that the coals are for the Brazilian Central Railways one naturally wonders how the National Coffee Council of Brazil comes into the business.

Handicaps to Business.

Since I wrote last week two announcements have been made showing the barriers that are being raised to the export of coal from this country. They may not be aimed specifically against British coals, but all the same this country is very much interested. In the first case the U.S.A. House of Representatives has voted in favour of an import tax of 2 dollars, or about 10s. 10d. per ton, on hard and soft coal. South Wales, and more especially the Swansea district, will suffer most by this decision. According to Mr. H. H. Merrett, of Gueret, Llewellyn and Merrett, Ltd., who was the first to export coal from this area to America, the intention is to impose a duty on goods produced by forced labour and the tax will operate in respect of Russian coal only. He says that he is not aware that the duty is to apply to all coals, but if such is the case it will certainly be a big blow to South Wales. In the other case the news is that the Spanish Government has approved of the Spanish transport tax being increased from 1 peseta to 2 pesetas per ton. This levy is to apply to all coal discharged at Spanish ports, and it is believed that the new impost operates as from April 1st, although confirmation of the actual date is awaited. The peseta is the equivalent of 5d., so that the advance in the tax is no small matter. Spanish ports already have the unenviable reputation of being about the dearest in Europe, and as in most cases when tonnage is chartered for carrying coals to Spain the stipulation is made for the taxes to be paid by the steamer, it is obvious that shipowners will seek an advance in the rate of freight to compensate them for the addition to the taxes.

Cardiff an Air Port.

The announcement was made recently that the Cardiff Corporation applied about a fortnight ago for a licence for the new air port at Pengam Farm, near Cardiff, so that there is every hope that in the near future Cardiff will not only be a definite port in the airways between London and Ireland, but also a centre for an extensive service between the South and South-West on the main line route to the North in connection with the Trans-atlantic liners.

Coalfield Items.

At the end of last week over 700 workmen at the Fforchaman Colliery of the Powell Duffryn Company were given fourteen days' notices. This colliery is one of the best-equipped and most up-to-date undertakings in the Aberdare Valley. It was reported at a meeting of the Executive Council of the South Wales Miners' Federation on Friday last that after prolonged negotiations a new price list had been agreed to for the Bedwas Colliery. It is to be hoped that this will mean more settled conditions at this undertaking, as for months past questions in dispute have resulted in interrupted work at the pits.

Current Business.

Market conditions in steam coals were generally quiet and there was no evidence of many orders having come along during the vacation. The suspension of work in the coalfield for the first three days of the week means a loss of output of approximately 350,000 tons of coal, but with the exception of a few grades standing supplies are easily obtainable. Prices in all departments are for the most part nominal.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE summer meeting of the Institution of Electrical Engineers will be held at the North Midland Centre from May 30th to June 3rd, 1932. The programme for the meeting is provisionally as follows:—On Monday evening, May 30th, a reunion will be held at the Grand Hotel, Harrogate. The party will leave Harrogate on Tuesday morning at 9.45 a.m. for Leeds, by motor coach, and will travel *vid* Harewood. On arrival at Leeds visits will be paid to the Leeds Corporation power station and the Central Electricity Board's sub-station at Kirkstall. At 12 noon the party will split up and Group 1 will return to Harrogate by motor coach and will lunch at the Grand Hotel. At 2.30 p.m. this group will visit Fountains Abbey. Group 2 will proceed from Kirkstall by motor coach to Huddersfield, where the party will be entertained to lunch by invitation of Hopkinsons, Ltd. After lunch a visit will be paid to the Britannia Works of Hopkinsons, Ltd. At 3.15 p.m. the party will proceed over the moors to tea at the Devonshire Arms, Bolton Abbey. The Mayor of Harrogate will hold a reception at the Grand Hotel, Harrogate, in the evening at 8.30 p.m.

On Wednesday, June 1st, the party will leave Harrogate at 10 a.m. for a visit to the Fryston Colliery of the Airedale Collieries, Ltd. At 11.45 a.m. the party will proceed to Dewsbury and will be entertained to lunch, by invitation of the Yorkshire Electric Power Company. After lunch a visit of inspection will be paid to the Thornhill power station of the Yorkshire Electric Power Company.

On Thursday, at 9.15 a.m., the party will proceed by train to Sheffield and will visit the Neepsend Power Station. Lunch will be provided at the Royal Victoria Hotel, by invitation of the Sheffield Corporation. During the afternoon a visit will be paid to the works of John Brown and Co., Ltd.

On Friday, June 3rd, the party will leave Harrogate by motor coach for York, where visits will be made to the Minster and the Guildhall. At 2.15 p.m. a visit will be paid to Terry's Chocolate Works. To bring the meeting to a conclusion a dance will take place at the Grand Hotel, Harrogate, from 8 p.m. to 1 a.m.

METER AND INSTRUMENT SECTION.

A visit to Rugby has been arranged by the Meter and Instrument Section for Saturday, May 7th, 1932. The party will leave Euston at 8.30 a.m. and on arrival at Rugby the works of the British Thomson-Houston Company, Ltd., will be visited. At 12.30 p.m. the party will have lunch as guests of the company. At 2 p.m. the party will leave the works and proceed by motor coach to the Post Office Rugby Radio Station, and at the conclusion of the inspection tea will be provided by the Post Office authorities.

CONTRACTS.

NEGRETTI AND ZAMBRA have received a contract to supply eight sets of dial thermometers, dial draught gauges, and multi-point electrical resistance thermometers for the new boilers at the Barking power station.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. F. K. NEATH, B.Sc., has resigned his position with the British Cast Iron Research Association to join the Keighley Laboratories, Ltd., Keighley, Yorkshire.

MR. L. G. HAWKINS, managing director of L. G. Hawkins and Co., Ltd., director of Pye Radio, Ltd., has been appointed director of the Electro-Thermic Development Company, Ltd., which company owns the Davy-Dajen patented mercury fuse and cut-out. L. G. Hawkins and Co., Ltd., have taken over the sole selling rights covering all countries and are now negotiating manufacturing licences with important British manufacturers.

THE INSTITUTION OF CIVIL ENGINEERS.—A meeting of the Institution will be held at Great George-street, Westminster, S.W. 1, on Thursday, April 7th, to consider a Provisional Report of a Sub-Committee of the Institution on the Drafting of Bills of Engineering Quantities, together with a List of the Units of Measurement to be Employed. The President of the Institution, Sir Cyril R. S. Kirkpatrick, will take the chair at 6 p.m.

DIESEL ENGINE LUBRICATION.—We have recently received from W. B. Dick and Co., Ltd., of 26, Grosvenor-gardens, S.W. 1, a brochure entitled "Scientific and Economic Diesel Engine Lubrication," by Mr. H. H. R. Drossi. Although dealing principally with the firm's "Ilo" lubricants, the author, after reviewing the general problem, passes on to the individual questions of cylinder, bearing, and air compressor lubrication, dealing with both slow and high-speed engine types. Some valuable information concerning the physical characteristics of lubricating oils, together with typical oil specifications for Diesel engines, are also given. The book concludes with notes for operating engines and particulars of the firm's British and foreign services.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—At the recent annual general meeting of the Finsbury Technical College Old Students' Association the following members were elected for the new Council:—President, E. G. Walker, M. Inst. C.E., M.I. Mech. E.; Immediate Past-President, H. G. Knight, F.I.C.; Members of Council, W. J. Jeffery, M.I.E.E., H. D. Symons, M.I.E.E., L. M. Clark, F.I.C.; Treasurer, W. B. Thompson, A.M.I.E.E.; Secretary, F. R. C. Rouse, A.M.I.E.E., A.M.I. Mech. E., 15, Clifton-gardens, Golders Green, N.W. 11. The annual dinner on March 12th was attended by ninety-four members and guests, the latter including Mr. W. M. Mordey, Hon. M.I.E.E., Mrs. Mordey, Dr. Scoble, Professor Catterson-Smith, and C. R. Darling. The dinner was followed by a musical programme.

STATISTICS AND STANDARDISATION.—A course of three lectures on "The *Rôle* of Statistical Method in Industrial Standardisation" will be given by Dr. W. A. Shewhart at University College, Gower-street, W.C. 1, on May 3rd, 5th, and 6th, at 5.30 p.m. Dr. Shewhart is a member of the technical staff of the Bell Telephone Laboratories, New York, and in these lectures an attempt will be made to outline the present status of the applications of modern statistics, and to call attention to certain fundamental problems in industrial development, the solution of which requires the use of not only some of the most recently developed theory, but also of theory not yet available. The lectures will be profusely illustrated. At the first lecture the chair will be taken by Sir F. E. Smith, K.C.B., C.B.E., F.R.S., Secretary of the Department of Scientific and Industrial Research. A detailed syllabus of the lectures may be obtained on application to the Academic Registrar, University of London, S.W. 7. Admission will be free, without ticket.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 22/6
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 3 6	3 3 6
No. 1	3 4 0	3 4 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*) / 4 0 6 (*b*) / 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 0 0	—
Best Bars	10 10 0	—
Double Best Bars	11 0 0	—
Treble Best Bars	11 10 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.	10 15 0	10 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 12 6	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	5 5 0 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	16/–
Block Tin (cash)	127 15 0
„ (three months)	129 10 0
Copper (cash)	32 16 3
„ (three months)	32 18 9
Spanish Lead (cash)	12 0 0
„ „ (three months)	12 2 6
Spelter (cash)	12 8 9
„ (three months)	12 16 3
MANCHESTER—	
Copper, Best Selected Ingots	36 0 0
„ Electrolytic	37 0 0
„ Strong Sheets	66 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	13 15 0
„ Foreign	11 15 0
Spelter	12 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£26 8 6	7/–
„ „ 6 p.c. to 8 p.c.	£23 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£23 0 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£40 0 0	10/–
„ „ „ 1 p.c. carbon	£55 0 0	12 –
„ „ „ 0·70 p.c. carbon	£57 10 0	13/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– per unit	
„ „ 75 p.c.	£17 15 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
„ „ Ell	14/3
„ „ Splint	14/– to 16/–
„ „ Trebles	12/6
„ „ Doubles	10/6
„ „ Singles	9/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	16/6
„ „ Trebles	12/6
FIFESHIRE—	
(f.o.b. Methil or Burnt island)—Steam	11/6 to 12/3
Screened Navigation	16/6
Trebles	12/6 to 13/6
Doubles	10/3 to 10/6
Singles	9/3 to 9/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/9 to 12/–
Secondary Steam	11/6
Trebles	11/6 to 12/–
Doubles	10/–
Singles	9/6

(8) N.W. COAST— ENGLAND.

Steams	21/9
Household	32/6 to 51/6
Coke	20/– to 22/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	9/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/6 to 27/6	—
South Yorkshire Best	22/– to 23/–	—
Derbyshire Best Bright House	22/– to 23/–	—
Screened House Coal	19/– to 20/6	—
Best Screened Nuts	17/– to 18/–	—
Small Screened Nuts	14/6 to 15/6	—
Yorkshire Hards	16/– to 18/–	—
Derbyshire Hards	16/– to 18/–	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/– to 8/6	—
Smalls	5/– to 6/–	—
Blast-furnace Coke (Inland)	12/– to 12/6 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	19/6 to 21/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/– to 48/6
Beans	28/6 to 32/6
Peas	18/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Seconds, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Shipping Crisis.

THE annual report presented by Monsieur de Rousiers, of the Comité Central des Armateurs de France, is necessarily a catalogue of the difficulties that have overtaken French shipowners, and as those difficulties are of an international character, and are aggravated by the measures adopted in defence of national interests, the State has been able to do little for the protection of the shipping industry. When shipowners found that they could not look for much help from the State they endeavoured to compete for foreign freights by extending their operations to the North-West of Europe. Their initiative failed to give profitable results, and, when trade restrictions and the system of import quotas were followed by a further contraction of freights, the situation became still more precarious and finally culminated in disaster with the fall of the pound. The laying up of ships and the throwing of seamen out of work have compelled the Central Committee to submit another proposal to Parliament which will enable shipowners to live through the crisis. The new plan provides for the payment of an indemnity to shipowners representing an amount calculated on the basis of the tonnage in service each day, which amount will vary according to the speed of the ships and the length of their voyages, and it will be further increased for any addition in the number of seamen employed in proportion to the tonnage. Monsieur de Rousiers believes that such assistance will remove the difficulty that has overtaken shipowners and will enable them to carry on until conditions improve.

The Coal Industry.

Coalowners have been endeavouring to convince the Government and the public that the existence of their industry depends upon a more rigid application of the import quota system whereby the home market will be reserved for as much native fuel as will keep the men employed. In the interests of consumers the Government has been obliged to keep the quotas within reasonable limits. Coalowners consider that these limits are too narrow, and the annual report of Monsieur Peyerhimoff, on behalf of the Comité Central des Houillères de France, presents data and arguments mainly with a view to enforcing the claim for a further restriction of coal imports. All the countries, it is declared, have reduced their production except Holland, Belgium, and Poland. The output of the eight principal countries in 1931 was 54 million tons less than in 1930, and nearly 100 million tons below that of 1929. Nevertheless, stocks at the Continental collieries amount to about 35 million tons. The report gives "alarming figures" to show the decline of the colliery industry in the Nord and the Pas de Calais, while it is stated that there has been a comparatively small reduction in the imports of foreign fuel, including composite fuels, from Germany. Reference is made to the increasing imports of anthracite from Tonkin, and it is implied that, eventually, the French Empire may be able to supply France with all the fuel she needs without the necessity of importing anything from abroad. Consumers, however, are entirely opposed to any curtailment of supplies which may have the effect of increasing the cost of an essential raw material.

The Transatlantic Liners.

The Government has been authorised by Parliament to guarantee a public loan of 68,745,000f. to the Compagnie Générale Transatlantique for the completion of ships on the stocks, the guarantee being covered by a mortgage on the company's buildings and fleet. This step will allow of work being resumed at Saint-Nazaire on the "Champlain," and at Rouen and Dunkirk on two cargo boats. Although the previous expenditure authorised by the Financial Commission of the Senate was intended to allow the Government to ensure the carrying on of the Transatlantic services during a period of six months, and did not include resumption of work on the 70,000-ton liner at Saint-Nazaire, the construction of that ship is, nevertheless, being continued.

Railway Working.

The reports of the railway companies confirm the unfavourable impressions regarding the past year's working. Even the Paris-Orleans Company, which serves a purely agricultural part of the country, and is, therefore, less liable to fluctuations, experienced a heavy contraction of receipts. The State alone profited from the company's operations, the taxes on the company itself and on goods and passenger traffic reaching nearly 409 million francs, while the economies realised by the State in postal, military, naval, and other transport services exceeded 161 million francs. The heavy hand of the State paralyses the railway companies. The work of electrifying the Paris-Orlean system was suspended at the end of 1926 on account of the unsatisfactory financial situation, but the sale of current from the hydro-electric plants in the Massif Central has now enabled the company to resume operations by extending the electrical equipment from Orleans to Tours, and when that work is completed, at the end of next year, operations will be started on the line from Vierzon to Brive. Last year 9,321,910 train-kilometres were run on the electrified lines, and the consumption of energy was 127 million kWh. It is stated that there was an economy of 2·4f. per train-kilometre in the cost of running and upkeep of rolling stock as compared with steam traction. It should be remembered, however, that the Paris-Orleans railway system is not favourably situated as regards coal supplies, and it possesses hydro-electric power stations at Eguzon and Coindre, which deliver about one-half of the available current to Paris. To provide for the new electrified sections the company has begun the construction of a dam at Marèges, on the Dordogne, and this work will be followed by the Cellette and Chavanon dams. The Marèges installation will have a capacity of 120,000 kW and the Cellette 45,000 kW.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

366,795. April 17th, 1931.—PRE-COMBUSTION CHAMBERS, Hannoversche Maschinenbau-Actien-Gesellschaft, vormals Georg Egestorff (Hanomag), of Hannover-Linden, Germany, and Lazar Schargorodsky, of 13, Sonnenweg, Hannover, Germany.

With a pre-combustion chamber A, disposed excentrically in the cylinder head, which communicates with the main combustion chamber through a plurality of holes, it is desirable that the jets issuing from those holes should all arrive at the walls of the main combustion space with their kinetic energy equally dissipated. As a consequence, the diameters of these holes B

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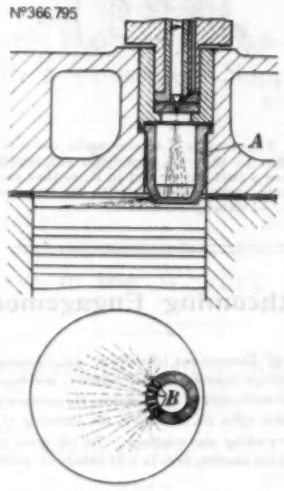

are graduated according to the length of path of the jet to the cylinder wall. It is suggested that "if, for example, for the supply of the air and fuel mixture for the whole cross section of the cylinder an outlet opening of 8 mm. is necessary, then if, for instance, six outlet passages are provided, these latter are not all made equal to one-sixth of 8 mm., but are varied so that, for instance, two passages of 3 mm. each may be provided for the longest jet, two passages of 2·8 mm. each for the central jets, and two openings of 2·5 mm. each for the shortest jets."—*February 11th*, 1932.

366,810. April 16th, 1931.—CARBURETTERS FOR HEAVY OILS, Société Anonyme Le Carbone, 37, Rue de Paris, Gennevilliers (Seine), France.

This carburetter is intended for heavy oils, which require additional heat for their vaporisation, which is supplied by exhaust gases passing through the chamber A. The constant

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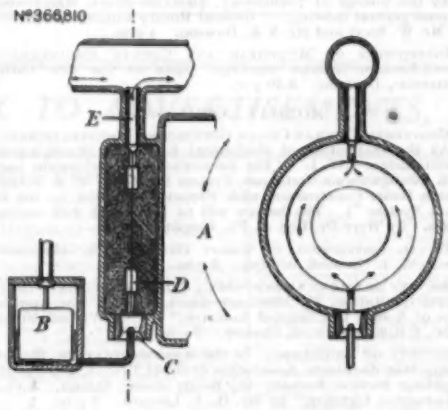

level float valve B supplies the oil to the jet C, which delivers into the annulus D between two blocks of highly porous carbon, that are heated by the exhaust. The outlet pipe E from the carburetter is lined with activated carbon. In this way it is said the deposition of tarry matter in the carburetter is prevented.—*February 11th*, 1932.

DYNAMOS AND MOTORS.

366,145. September 30th, 1930.—TOOLS OR DEVICES FOR BUILDING UP LAMINATED CORES FOR DYNAMO-ELECTRIC MACHINES, William Harding Scott, Paul Alphonse Hubert Mossay and Gilbert James Scott, all of Gothic Works, Norwich, Norfolk.

An object of this invention is to enable the laminæ of electrical machines to be rapidly and easily assembled in pack formation, while eliminating or reducing to the minimum the risk of deformation frequently incurred. The mandrel A carries a saddle or hub B to receive the annular laminæ C. The saddle has a flange D which forms a back-pressure plate for the laminæ and has prolongations E extending beyond the end of the mandrel. The upper portion of the saddle B conforms substantially to the curvature of the inner edges of the laminæ, while the lower portion is open as shown, or, alternatively, may be curved or shaped to provide a clearance between it and the inner edges of the laminæ. The saddle is rotatably supported on the mandrel A and a locking bolt or plunger F is fitted in the pedestal to engage in a recess in the flange or back-pressure plate D, and so prevent unintentional rotation of the saddle, when positioned. The mandrel has a screwed stem G on which is freely mounted the hub H and extension sleeve J of a front pressure ring K. The pack of laminations is compressed between the front-pressure ring K and back-pressure plate D, by screwing up the nut L. Screw clamps M may be applied over the pressure plate D, and ring K, to exert an extra pressure and maintain the pack consolidated while connections are applied to secure

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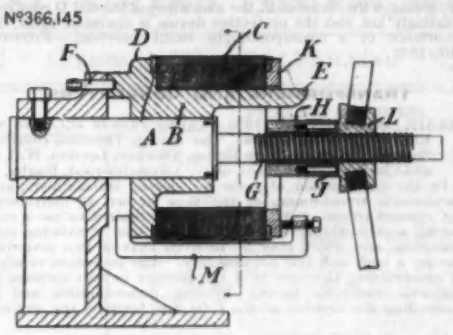

the laminæ permanently against relative displacement and so produce a compact body which can be readily handled and is ready for immediate winding, when removed from the saddle B. By withdrawing the bolt F the saddle B, with the pack of laminæ thereon, can be turned on the mandrel to bring any desired part of the pack into a position readily accessible to the operator.—*February 1st*, 1932.

366,215. December 15th, 1930.—ELECTRICAL MACHINES, APPARATUS AND APPLIANCES OF THE FLAME-PROOF TYPE, Verityn, Ltd., of Plume and Victoria Works, Aston, Birmingham, and Horace Will Smallwood, of 112, Rectory-road, Sutton Coldfield, Birmingham.

The invention relates to electrical machines, apparatus and appliances of the flame-proof or flash-proof type—that is to say, in which the attached joint facings or flanges or the enclosing casings or parts are provided to admit of internal ventilation, but in such manner that highly explosive exterior gases cannot reach the interior of the machine or apparatus, and *vice versâ*. The invention is particularly applicable to fan motors of the

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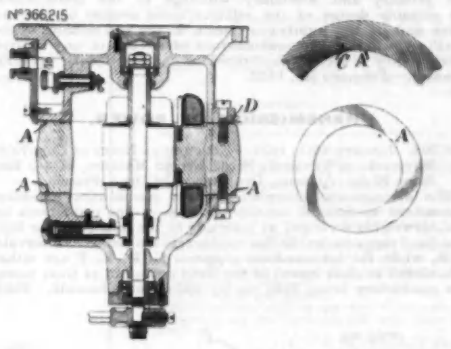

totally enclosed type. The grooved facing or flange A, of ring form, is V-grooved throughout its area on curved lines, as at C, crossing the surface obliquely or at an angle to radial lines, the grooves being evenly formed in the face so that the rises between are also even and will make a gastight joint with the plain joint facing or flange D with which the grooved face A has to co-operate. The facing, consequently, has a series of grooves throughout its surface of small depth, for example, each less than ten-thousandths of an inch, and each groove communicates directly from the interior diameter to the exterior diameter, so that for a given depth of flange the grooves have a curved form rendering the joint flash-proof, while, at the same time, providing sufficient ventilation.—*February 4th*, 1932.

366,851. June 16th, 1931.—PROTECTIVE SYSTEMS FOR DYNAMO-ELECTRIC MACHINES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

To disconnect the motor from the source of supply an overload protective device A is provided having a latch member B adapted to be raised by a plunger or armature provided with differentially wound coils C and D. The winding C is a trip coil connected in series with the armature of the machine, while the coil D is connected in series with the field winding E. Since the coil D is wound differentially with respect to the coil C, it opposes the tendency of the coil C to cause the

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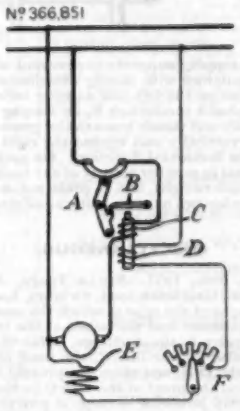


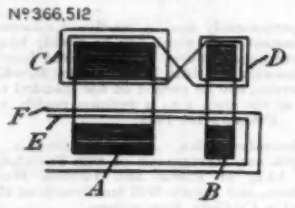
plunger to raise the latch B and thereby open the overload protective device A. The rheostat F is provided to vary the resistance in the field winding circuit in order to control the speed of the motor. In the operation of the system the overload setting of the protective device is automatically varied in accordance with variations in the field current of the motor in such manner that the protective device is operated to disconnect the motor and thus limit its overload to the permissible overload which it is capable of commutating with the particular field excitation being used. Thus, when the rheostat F is adjusted to give a comparatively high field current, under which condi-

tions the motor is adapted to carry a heavy overload, the excitation of the coil D in the field circuit is correspondingly high, and therefore a correspondingly high current in the coil C is required to operate the protective device. In other words, the current in the coil C, which is proportionate to the load on the motor, must be high enough under any conditions to first overcome the differential coil D and then operate the protective device. Conversely, when the field excitation is reduced, by cutting in the rheostat F, the excitation of the coil D is correspondingly low and the protective device is operated upon the occurrence of a correspondingly small overload.—*February 11th*, 1932.

TRANSFORMERS AND CONVERTERS.

366,512. September 5th, 1930.—IMPROVEMENTS RELATING TO ELECTRIC TRANSFORMERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Charles Gilbert Mayo, of 17, Alexandra-road, Rugby.

In the construction of cores for electric transformers, and particularly transformers of the type known as instrument and current transformers, it is frequently desired to use a core having a permeability which differs from that of existing core materials, and which may lie between that of two materials having a high and low permeability. The invention consists in constructing the core of a transformer in two sections of magnetic materials having differing permeabilities, and in controlling the division of the total flux between the sections

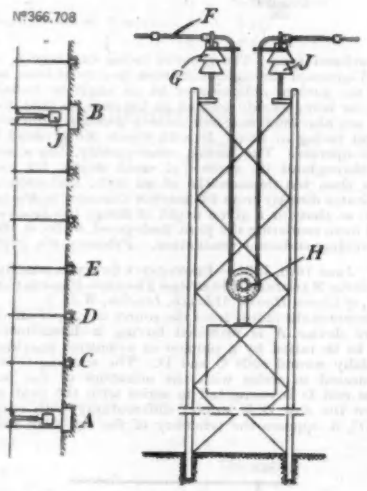


by means of an auxiliary winding. By this means, the core punchings are all made the same size, but the resultant permeability curve can be made smooth and to lie at any desired distance between the permeability curves of the separate materials. The two core sections are represented at A and B, C and D designating the sections of the auxiliary winding embracing the core sections A and B, while E and F indicate the primary and secondary windings of the transformer. By suitable design of the relative cross section of the two cores and of the number of turns in the two sections of the auxiliary winding the manufacture of a core of any desired permeability is greatly facilitated as compared with previous practice.—*February 5th*, 1932.

TRANSMISSION OF POWER.

366,708. January 26th, 1931.—ELECTRICAL LINES OF CONSTANT MECHANICAL TENSION, Marie Ernest Mathieu, of 46, Rue Saint Blaise, Alençon, Department of Orne, France.

The arrangement described in this specification produces a constant mechanical tension or stress in line conductors by counterweights arranged at intervals in the length of the line. The fixed supports for the line conductors are placed at intervals, A–B, while the intermediate supports C, D, E, F are either articulated at their bases, or are fixed or dug in at their bases, the conductors being held up by sliding attachments. Each

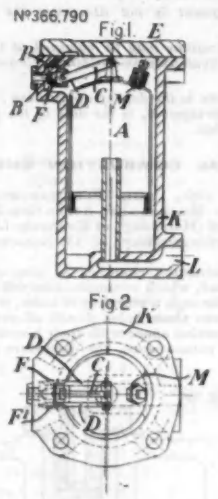


of the fixed or stopping supports is provided at the top with two series of insulators with sliding attachments for the conductors, one series on the left and another series on the right. Each of the left-hand conductors F, on leaving its insulator G, descends vertically and passes beneath the groove of a pulley H, and rises again vertically and rejoins the right-hand insulator J and resumes its horizontal direction. On each of the pulleys H, which are equal in number to that of the conductors, there is suspended a counterweight, but, if preferred, a single counterweight may serve for two or more pulleys.—*February 11th*, 1932.

MISCELLANEOUS.

366,790. March 30th, 1931.—STEAM TRAPS, J. Butterworth, High Meadow, Grosvenor-road, Swinton, Lancs.

This steam trap is of the type in which the chamber is subject to the working pressure and the outlet of the trapped water is controlled by a valve in the discharge. This valve is shown at B, and is controlled by the link C, the head of the float A is guided by the links D D, and these are pivoted to the casing K at a point F behind the pivot of the link C on the valve B. The result is that a very powerful leverage is provided for breaking the valve open, and for reclosing it, while, after having been broken off its seating it opens quickly. The normal position of the float A is at the bottom of the box or vessel K containing it, and the action of the trap is as follows:—Air and water enter at L and pass into the float A. The air escapes through the small adjustable valve M, while the water flows out at the bottom of the float, from which it passes out of the trap through the outlet valve B. When all the water has passed and steam enters the float A, it drives the water out of the latter, which becomes buoyant, rises and closes the valve B. After the valve B closes, the steam begins to escape through the air valve M until the float A loses its buoyancy, falls and opens the valve B. If water then flows into the trap, the valve remains open until it is discharged. If, on the other hand, steam flows into the trap, it drives the water out of the float as before and closes the valve, when the cycle of operations is repeated. It will be obvious that by opening the air valve M the rapidity of the action of the trap can



be increased. The passage P to the outlet valve B is placed as high as possible, so that its upper end touches the cover R, which latter has a port cut or cast in it, so that any air collecting in the trap is discharged along with the water each time the valve B opens.—*February 11th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN STUDENTS' SECTION.—In the Cinema of the Newcastle-upon-Tyne Electric Supply Company, Ltd., Carliol House, Newcastle-upon-Tyne. "Patent Office Procedure," by Mr. I. J. A. Crawshaw; and "Short Circuit Calculations," by Mr. G. G. Smail. 7.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Development in Electrically Welded Fabrication," by Mr. E. P. S. Gardner. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—The Engineers' Club, 17, Albert-square, Manchester. Annual general meeting. 7 p.m. "The Lay-out of Machine Tools and Equipment for Economical Production," by Mr. W. Care. 7.15 p.m.

SATURDAY, APRIL 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—At the College of Technology, Sackville-street, Manchester. Annual general meeting. "General Rotary Furnace Practice," by Mr. W. Scott and Mr. S. E. Dawson. 4 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting. Meet at the new baths, Waterside, Durham. 2.30 p.m.

MONDAY, APRIL 4TH.

ENGINEERS' GERMAN CIRCLE (DEUTSCHER INGENIEURZIRKEL).—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. "Ein neuzeitliches Kesselsystem nach dem Zwangumwalz-Verfahren, System La Mont" ("A Modern Steam Boiler Construction with Forced Circulation, on the La Mont System"). The lecture will be illustrated with lantern slides. By Herr Dr.-Ing. A. Th. Herpen. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, W. 1. General meeting. 5 p.m.

SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION.—In the Royal Institution, 21, Albemarle-street, W. 1. "The Application of X-rays to Chemical Industry," by Sir William Bragg, O.M., F.R.S., and Dr. G. Shearer. 8 p.m.

SOCIETY OF ENGINEERS.—In the Apartments of the Electric Lamp Manufacturers' Association of Great Britain, Ltd., at the Lighting Service Bureau, 15, Savoy-street, Strand, W.C. 2. "Industrial Lighting," by Mr. H. A. Lingard. 6 p.m.

TUESDAY, APRIL 5TH.

DIESEL ENGINE USERS ASSOCIATION.—Coventry Restaurant, Wardour-street, Piccadilly-circus, W. 1. Annual dinner. 7 for 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—Hotel Metropole, Leeds. Annual general meeting. 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND STUDENTS' SECTION.—At Birmingham University, Edmund-street, Birmingham. "Some Applications of Electric Motors," by Mr. J. C. Turnbull. 7 p.m.

WEDNESDAY, APRIL 6TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. "The Flash-arc in High-power Valves," by Mr. B. S. Gossling. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH-EASTERN BRANCH.—Mining Institute, Neville Hall, Newcastle-upon-Tyne. "Industrial Conditions in Russia," by Mr. John Fearn. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Light Sensitive Cells in the Service of Man," by Dr. F. H. Constable. 8 p.m.

SOCIETY OF GLASS TECHNOLOGY.—In the Science Museum, South Kensington. "Statistical Methods of Handling Test Results, with Special Reference to the Testing of Glassware." The discussion will be opened by Mr. Bernard P. Dudding. 7.30 p.m.

THURSDAY, APRIL 7TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Meeting "To Consider a Provisional Report of a Sub-Committee of the Institution on the Drafting of Bills of Engineering Quantities, together with a List of the Units of Measurement to be Employed." 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. "Modern Communication Systems," by Dr. F. Lüschen. 6 p.m.

FRIDAY, APRIL 8TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Joint Meeting of the Meter and Instrument Section and the Wireless Section. "Some Acoustic and Telephone Measurements," by Mr. H. R. Harbottle. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. Informal meeting. Discussion, "Training for Management," introduced by Mr. T. G. Rose. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: MIDLAND BRANCH, GRADUATES' SECTION.—Chamber of Commerce, New-street, Birmingham. "Bridge Construction," by Dr. C. H. Shirley Smith. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Design and Manufacture of Taps, with Notes on Screwing Dies," by Mr. W. Wood. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, E.C. 4. "The Metropolitan Railway, Past and Present," by Mr. B. Robert White. 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY: CHEMICAL ENGINEERING GROUP.—Meeting in Sheffield. Leave Royal Victoria Hotel, adjacent to the Victoria Station, by motor coach for Hadfields' works. Visit to the works of Hadfields, Ltd. 2.15 p.m. Royal Victoria Hotel, Sheffield. "Special Alloy Steels as Applied to Chemical Engineering," by Messrs. T. G. Elliot, R. J. Sarjant, and Wm. Cullen. 6 p.m. Informal dinner, 8 p.m.

MONDAY, APRIL 11TH.

INSTITUTION OF SANITARY ENGINEERS.—At Caxton Hall Westminster, S.W. 1. "Cement," by Mr. D. B. Butler. 7 p.m.

TUESDAY, APRIL 12TH.

CITY OF LONDON.—The Sir John Cass Technical Institute, Jewry-street, Aldgate, E.C. 3. Commencing a series of seven lectures on "Power Plant, Diesel and Semi-Diesel Engines," by Mr. E. L. Bass. Tuesday evenings, 6.45 p.m. to 8.15 p.m.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—Crystal Palace. 178th Award of Certificates, by Mr. A. M. A. Struben. 3 p.m.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "Lubrication of Diesel Engines," by Engineer Lieut.-Commander H. J. Nicholson. 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. Annual general meeting. 7.30 p.m.

WEDNESDAY, APRIL 13TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Rural Industries, their Organisation and Development," by Mr. J. R. I. Brooke. 8 p.m.

THURSDAY, APRIL 14TH.

INSTITUTE OF MARINE ENGINEERS.—The Minories, E.C. 3. Junior Section meeting. "Practical Hints on the Operation and Maintenance of Marine Electrical Machinery," by Mr. D. M. Cathcart. 7 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Annual general meeting and open discussion on "Welding, Brazing, and Soldering." 7.30 p.m.

FRIDAY, APRIL 15TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Rocket Propulsion," by Dr. Herbert Chatley. 7.30 p.m.

WEDNESDAY, APRIL 20TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "China and the Future of Our Far Eastern Trade," by Mr. J. O. P. Bland. 4.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Instalment Buying," by Mr. J. Gibson Garvie. 8 p.m.

FRIDAY, APRIL 22ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. "The Film Lubrication of the Journal Bearing," by Messrs. R. O. Boswall and J. C. Brierley. 6 p.m.

SATURDAY, APRIL 23RD.

INSTITUTE OF BRITISH FOUNDRYMEN: JUNIOR SECTION.—In the College of Technology, Manchester. Annual general meeting. "The Merits of Oil Bonded Sands," by Mr. A. L. Key. 7 p.m.

WEDNESDAY, APRIL 27TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Education for Commerce," by Mr. H. Ramsbotham, M.P. 8 p.m.

THURSDAY, APRIL 28TH.

DIESEL ENGINE USERS ASSOCIATION.—Caxton Hall, Westminster, S.W. 1. "Cylinder Liner Wear," by Eng. Rear-Admiral J. Hope Harrison. 3.30 p.m.

SATURDAY AND SUNDAY, APRIL 30TH AND MAY 1ST.

ENGINEERING GOLFING SOCIETY.—Spring meeting at Burnham-on-Sea, Somerset. Full particulars may be obtained from the Honorary Secretary, Mr. G. H. Hopewell, Foster Wheeler, Ltd., Aldwych House, London, W.C. 2.

TUESDAY, THURSDAY, & FRIDAY, MAY 3RD, 5TH, & 6TH.

UNIVERSITY OF LONDON.—In the Department of Applied Statistics, University College, Gower-street, W.C. 1. Advanced Lectures in Statistics. Three lectures, "The *Rôle* of Statistical Method in Industrial Standardisation," by Dr. W. A. Shewhart. 5.30 p.m. each day. Admission free.

WEDNESDAY, MAY 11TH.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May Lecture, "The Plastic Deformation of Metals," by Professor F. Körber. 8 p.m.

TUESDAY, JULY 5TH, TO SATURDAY, JULY 9TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Royal Show at Southampton.

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